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ZONE B BACKGROUND INFORMATION CNC CHARLESTON SC
5/20/1997
NAVFAC SOUTHERN

ZONE B BACKGROUND

5090/11
Code 1877
12 May 1997

Mr. G. Randall Thompson
Director, Division of Hazardous and Infectious Waste Management
Bureau of Solid and Hazardous Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia SC 29201

Subj: ZONE B RCRA FACILITY INVESTIGATION REPORT

Dear Mr. Thompson:

The purpose of this letter is to provide changes in the background reference values for Zone B RCRA Facility Investigation (RFI) Report which has been approved by the Department and EPA representatives. The changes have occurred through discussion with the Naval Base Charleston Project Team, which includes representatives of the Navy, the Department and the U.S. EPA Region IV.

Background reference values for inorganics in upper and lower interval Zone B soils have been reviewed and revised, based largely on the location, origin, and former use of the land from which the grid-based samples were collected. Two of the sample locations (GDBSB001 and GDBSB002) fell in the portion of the zone known to consist of fill material. Examination of analytical results from samples collected at these two locations showed that reported concentrations of inorganics were consistently higher than for other grid-based samples for both upper and lower interval soil. Consequently, samples from these locations have been dropped from the soil datasets for all inorganics as being unrepresentative of conditions in the rest of the zone. Samples from two additional locations (GDBSB003 and GDBSB011) were dropped from the arsenic datasets because the locations fell within the boundary of the former golf course. Elevated arsenic levels in the golf course samples indicated possible past use of arsenate-based herbicides on the fairways and greens. Background reference values for two inorganics (arsenic and chromium) in lower interval soil were further revised after removing the samples discussed above because their reduced datasets could not be transformed into approximately normal distributions. Since conventional statistical measures (mean, standard deviation, etc.) could not be obtained, nonparametric rather than parametric upper tolerance limits were used as background values for these two metals.

Please also note that the text of the Zone B memo dated 3-3-97 (or 3-10-97) contains an incorrect value for the arsenic UTL for lower interval soil. The UTL is shown as 11.7 mg/kg, which is the maximum value in the dataset. This value came from sample GDBSB01102, which should have been dropped as a golf course sample, leaving 10.8 mg/kg as the highest value and, therefore, the correct nonparametric UTL. The value is shown correctly on the Zone B soil table that was handed out at the same time.

Subj: ZONE B BACKGROUND REFERENCE VALUES

This completes all outstanding issues with the Zone B RCRA Facility Investigation. Since AOC 507 was determined to require No Further Action during the March Project Team meeting, the Navy withdraws the request for permit modification to require a Corrective Measures Study at this site. Instead, please initiate permit modifications to indicate that No Further Action (NFA) is required. If you should have any questions you may contact me at (803) 820-5525.

Sincerely,

Matthew A. Hunt

MATTHEW A. HUNT
Environmental Engineer
Installation Restoration III Branch

Copy to:
SCDHEC (Paul Bergstrand, Johnny Tapia)
USEPA (Jay Bassett)
CSO Naval Base Charleston (Billy Drawdy, Daryle Fontenot)
Ensafe/Allen & Hoshall (Todd Haverkost)
SOUTHNAVFACENGCOM (Brian Stockmaster)
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Zone B 3-24-97

Outliers removed from grid-based background datasets

Surface soil

Aluminum	GDBSB00101	47,900 mg/kg
	GDBSB00201	39,500 mg/kg
	GDBSB01101	24,000 mg/kg
Arsenic	GDBSB00101	19.6 mg/kg
	GDBSB00201	22.1 mg/kg
	GDBSB00301	9.0 mg/kg
	GDBSB01101	28.7 mg/kg
Beryllium	GDBSB00101	1.45 mg/kg
	GDBSB00201	1.2 mg/kg
Chromium	GDBSB00101	63.8 mg/kg
	GDBSB00201	54.8 mg/kg
Manganese	GDBSB00101	499.5 mg/kg
	GDBSB00201	454 mg/kg
Vanadium	GDBSB00101	89.95 mg/kg
	GDBSB00201	71.9 mg/kg

Subsurface soil

Aluminum	GDBSB00102	55,600 mg/kg
	GDBSB00202	32,900 mg/kg
Arsenic	GDBSB00102	33.9 mg/kg
	GDBSB00202	15.8 mg/kg
	GDBSB01102	11.7 mg/kg
Chromium	GDBSB00102	75.7 mg/kg
	GDBSB00202	48.5 mg/kg

Zone B soil 3-24-97

Alternative background reference values (mg/kg)

	Surface Soil					Subsurface Soil				
Chemical	RBC	2xMean	$UTL_{90,90}$	$UTL_{95,95}$	$UTL_{[illegible]}$	SSL	2xMean	$UTL_{90,90}$	$UTL_{95,95}$	$UTL_{[illegible]}$
Aluminum	7,800n	19,400	13,900	15,500	15,500	--	--	--	--	--
Arsenic	0.43c	8.9	12.4	17.1	17.1	29	5.3	10.8	10.8	35.52
Beryllium	0.15c	0.86	0.95	1.23	1.34	--	--	--	--	--
$Chromium_{+6}$	39n	35.6	48.3	75.7	80.2	38	24.9	48.1	48.1	83.86
Manganese	180n	358	385	464	589	--	--	--	--	--
Vanadium	55n	34.5	47.8	~~76.3~~ 52	156	--	--	--	--	--
			s= 1.966	2.736		Using DAF of 20				

RBC values are adjusted for THQ = 0.1 to allow for multiplicative effects.
SSL values assume DAF = 20.

MEMO 3-10-97

TO: Project Team members
FROM: EnSafe

RE: Summary of dataset adjustments, data transformations, and calculations used to obtain background reference values for Zone B

Because datasets for grid-based soil samples in Zone B were large enough to allow computation of statistically based background reference values (n =15 for upper interval soil; n =14 for lower interval soil), upper tolerance limits (UTLs) with 95%coverage and 95% confidence were calculated for inorganics in soil. Background reference values were not calculated for inorganics in groundwater because groundwater was not sampled at AOC 507, which was the only site investigated in Zone B. As reported in a table dated 2-14-97 and faxed to the Project Team members following the February Team meeting, calculated background reference values for Zone B exceeded RBCs for upper interval soil for aluminum (UTL = 15,500 mg/kg; RBC = 7,800 mg/kg), arsenic (UTL = 17.1 mg/kg; RBC = 0.43 mg/kg), beryllium (UTL = 1.34 mg/kg; RBC = 0.15 mg/kg), chromium (UTL = 80.2 mg/kg; hexachrome RBC = 39 mg/kg), manganese (UTL = 589 mg/kg; RBC = 180 mg/kg), and vanadium (UTL = 156 mg/kg; RBC = 55 mg/kg). For lower interval soil, calculated UTLs exceeded generic soil screening levels (SSLs) for arsenic (UTL = 48.9 mg/kg; SSL = 29 mg/kg) and chromium (UTL = 75.7 mg/kg; hexachrome SSL = 38 mg/kg). This memo examines the data and calculations involved in determining those background reference values, listed above, which exceed their corresponding risk-based standards. Possible causes of the high background values are discussed. In most cases, background reference values are recalculated and revised.

As discussed in a memo distributed at the February Project Team meeting ("Zone B: Arsenic in surface soil grid samples," dated 2-5-97), the UTL for arsenic in upper interval soil was earlier lowered from 90.0 mg/kg to 17.1 mg/kg as a result of removing four grid samples (GDBSB00101, GDBSB00201, GDBSB00301, and GDBSB01101) from the arsenic dataset. They were removed because they had all been collected from the golf course portion of the zone, and were felt to have been influenced by possible past applications of herbicides containing arsenates. Two of the four sample locations (GDBSB001 and GDBSB002) fell in the portion of the zone known to consist of fill material. Examination of analytical results for these two sample locations showed that reported concentrations of inorganics were consistently higher than for other grid-based samples for both upper and lower interval soil, and they have consequently been dropped from the soil datasets for all inorganics as being unrepresentative of conditions in the rest of the zone. Calculations included in this package show results for both the original and reduced datasets.

Enclosed are analytical results for all Zone B grid-based soil samples; a copy of the 2-14-97 table presenting background reference values that exceed RBCs; relevant EPA guidance for generic soil screening levels and associated dilution-attenuation factors; a table of tolerance factors for datasets of various sizes; and histograms and normal probability plots (produced with EPA's GeoEAS program) for datasets used to calculate UTLs for inorganics in soil. Sample IDs that include a "C" (e.g., GDB-C-B008-01) represent field duplicates; analytical results are averaged with those of the primary sample to obtain a single value for each location. UTL calculations are discussed below.

Upper interval soil

The **aluminum** dataset for upper interval soil had one outlier (GDBSB01101) in addition to the two discussed above. After all three were removed, original data values (rather than transformed values) of the remaining samples represented the closest approximation to a normal distribution (pgs. 3a, 3b). The UTL is obtained by calculating

$$UTL = X + ks$$

where X = the sample mean, s = the sample standard deviation, and k = the tolerance factor (see enclosed table). In this case, the UTL equals [9714 + (2.736)(2126)] = 15,531 mg/kg, or **15,500 mg/kg** when rounded to three significant figures.

Enclosed **arsenic** materials include the February 5 memo concerning reduction of the UTL from 90.0 to 17.1 mg/kg, zonewide soil concentrations, and a map of sample locations. After removal of the four outliers, a square-root transformation (pgs. 5a, 5b) produced the closest approximation to normality based on skewness, kurtosis, coefficient of variation, box and whisker plot, and normal probability plot.* UTL = $[1.973 + (2.815)(0.769)]^2$ = **17.1 mg/kg**.

The two deleted outlier samples represented the two highest concentrations in the **beryllium** dataset. After their removal, the square-root transformation (pgs 5a, 5b) provided a somewhat better approximation of normality than original values. UTL = $[0.632 + (2.670)(0.179)]^2$ = **1.23 mg/kg**.

After removal of the two outlier samples from the **chromium** dataset, the LN-transformation (pgs. 4a, 4b) produced a much better approximation of normality than original data values. Because skewness was still positive after the LN-transformation, a square-root transformation was not attempted. The square-root transformation generally yields skewness roughly midway between those of original data and LN-transformed data. UTL = exp[2.711 + (2.670)(0.605)] = **75.7 mg/kg**. Also included in the package are analytical results for Zone B soil samples analyzed for total chromium (all soil samples) and hexavalent chromium (three field duplicates only); hexavalent chromium was detected in one of three samples, at a concentration of 0.3 mg/kg.

After removal of the two high outliers, a normal distribution of **manganese** was best represented by the original data values (pgs. 3a, 3b). UTL = 178.9 + (2.670)(106.7) = **464 mg/kg**.

As with all of the inorganic datasets, the two removed outlier samples reported the highest concentrations of **vanadium** in upper interval soil. After their removal, the LN-transformation (pgs. 4a, 4b) gave the closest approximation to a normal distribution for a dataset of n = 13. Although removal of an additional high data value (51.6 mg/kg at GDBSB01101) combined with LN-transformation produced a somewhat closer approximation to normality (pgs. 6a, 6b), this approach was rejected because the normal probability plot (pg. 6b) revealed an S-shaped curve that is characteristic of excessive trimming of the dataset. For the dataset illustrated on pg. 4a, UTL = exp[2.653 + (2.670)(0.630)] = **76.3 mg/kg**.

Revised UTLs for upper interval soil, based on the trimmed dataset of n = 13, are as follows:

Aluminum	15,500 mg/kg
Arsenic	17.1 mg/kg
Beryllium	1.23 mg/kg
Chromium	75.7 mg/kg
Manganese	464 mg/kg
Vanadium	76.3 mg/kg

Lower interval soil

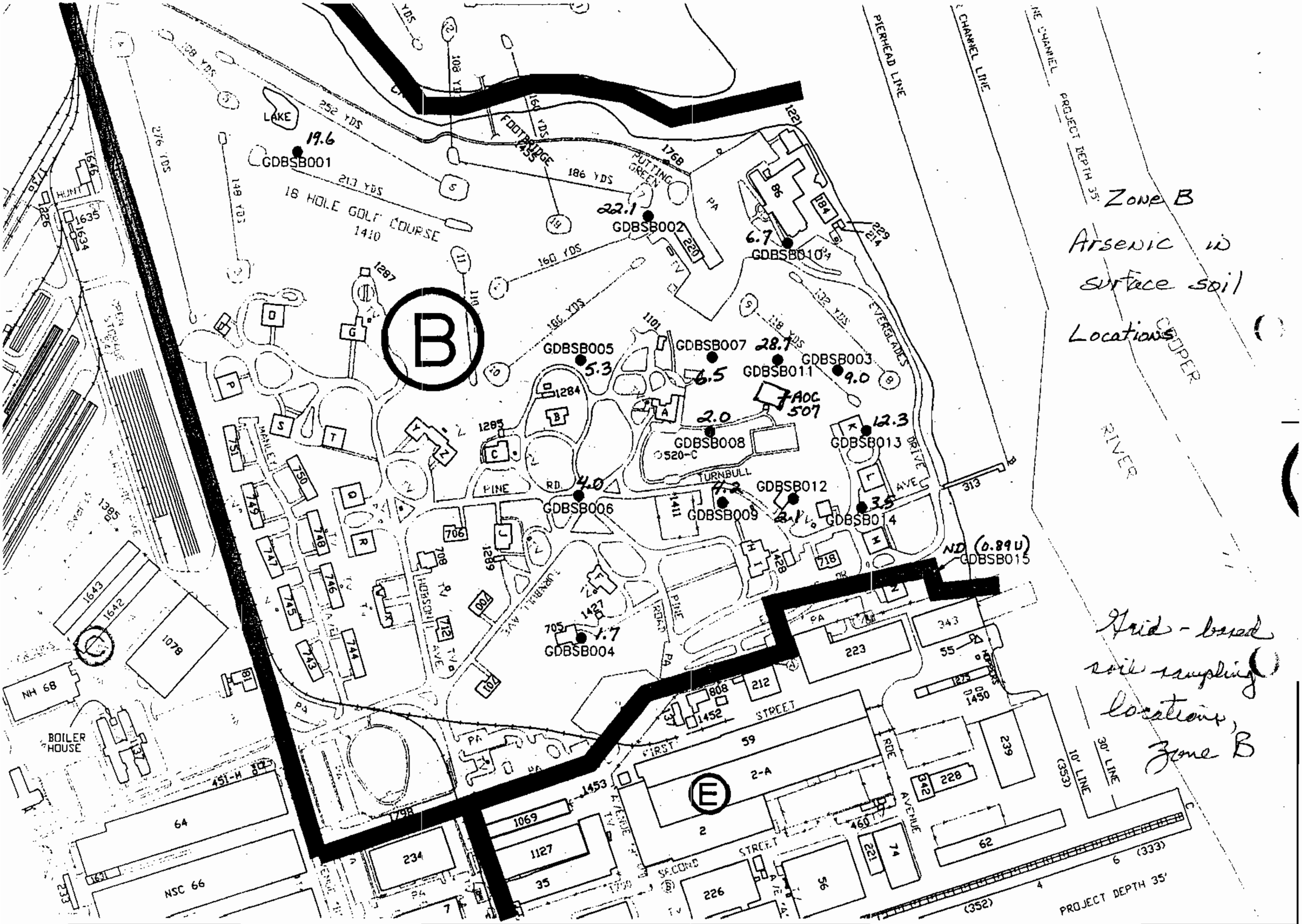
After removal of samples GDBSB00102 and GDBSB00202 as outliers, the dataset for **arsenic** was still skewed strongly to the right (pg. 3a). LN-transformation of the data yielded a distribution closer to normal, except for the four nondetect values on the left side of the histogram (pg. 4a). It is possible that the estimates of the nondetects are too low in this case (pg. 4b). Since the overall distribution is far from that of the bell-shaped curve of a normal distribution, a nonparametric UTL will be used in this instance: UTL = maximum detected value = **11.7 mg/kg**.

The reduced dataset for **chromium** is also skewed strongly to the right (pg. 3a), and remains positively skewed after LN-transformation (pg. 4a). A calculated UTL based on the transformed data would be: UTL = exp[2.065 + (2.736)(0.956)] = 108 mg/kg. This is an example of a somewhat inflated UTL due to the combination of a small dataset and a strongly skewed distribution. Under the circumstances, a nonparametric UTL might be more appropriate: UTL = maximum detected value = **48.1 mg/kg**.

Revised UTLs for lower interval soil, based on the trimmed dataset of n = 12, are as follows:

Arsenic	11.7 mg/kg
Chromium	48.1 mg/kg

* The Texas Natural Resources Conservation Commission (TNRCC), among others, mandates use of the Shapiro-Wilk test of normality for background datasets in projects under its jurisdiction. It has been EnSafe's experience that the Shapiro-Wilk test is too forgiving; that is, the test is too quick to find a dataset normally distributed when it is obviously not. For this reason, the Shapiro-Wilk test was not run on Zone B datasets.



Zone B
Arsenic in surface soil Locations
Grid-based soil sampling locations, Zone B
19.6 GDBSB001
22.1 GDBSB002
GDBSB003 9.0
1.7 GDBSB004
GDBSB005 5.3
4.0 GDBSB006
GDBSB007 6.5
2.0 GDBSB008
4.2 GDBSB009
6.7 GDBSB010
28.1 GDBSB011
GDBSB012 2.1
12.3 GDBSB013
3.5 GDBSB014
ND (0.89U) GDBSB015
AOC 507
B
E
18 HOLE GOLF COURSE 1410
FOOTBRIDGE
PUTTING GREEN
LAKE
PINE RD.
TURNBULL AVE
EVERGLADES DRIVE
FIRST STREET
SECOND STREET
PIERHEAD LINE
CHANNEL LINE
PROJECT DEPTH 35'
COOPER RIVER
BOILER HOUSE
NH 68
NSC 66

MEMO 3-6-97

TO: Project Team members
FROM: EnSafe

RE: Summary of dataset adjustments, data transformations, and calculations used to obtain background reference values for Zone H

Because datasets for grid-based soil and groundwater samples in Zone H were large enough to allow computation of statistically based background reference values (n =104 for upper interval soil; n =63 for lower interval soil; n = 11 for both shallow and deep groundwater), parametric upper tolerance limits (UTLs) with 95% coverage and 95% confidence were calculated for inorganics in these four media categories. For datasets with fewer than 50% but more than 10% detections, nonparametric UTLs were obtained by choosing the largest or second largest detected value, depending on the size of the dataset. As reported in a table dated 2-14-97 and faxed to the Project Team members following the February Team meeting, calculated background reference values for Zone H equaled or exceeded RBCs for upper interval soil for aluminum (UTL = 25,310 mg/kg; RBC = 7,800 mg/kg), arsenic (UTL = 14.81 mg/kg; RBC = 0.43 mg/kg), beryllium (UTL = 1.466 mg/kg; RBC = 0.15 mg/kg), chromium (UTL = 85.65 mg/kg; hexachrome RBC = 39 mg/kg), manganese (UTL = 636.4 mg/kg; RBC = 180 mg/kg), thallium (UTL = 0.63 mg/kg; RBC = 0.63 mg/kg), and vanadium (UTL = 77.38 mg/kg; RBC = 55 mg/kg). For lower interval soil, calculated UTLs exceeded generic soil screening levels (SSLs) for arsenic (UTL = 35.52 mg/kg; SSL = 29 mg/kg), chromium (UTL = 83.86 mg/kg; hexachrome SSL = 38 mg/kg), and thallium (UTL = 1.3 mg/kg; SSL = 0.7 mg/kg). For shallow groundwater, UTLs exceeded tap water RBCs for arsenic (UTL = 27.99 μg/L; RBC = 0.045 μg/L), barium (UTL = 323 μg/L; RBC = 260 μg/L), manganese (UTL = 3,391 μg/L; RBC = 84 μg/L), and thallium (UTL = 7.66 μg/L; RBC = 0.29 μg/L). For deep groundwater, UTLs exceeded tap water RBCs for arsenic (UTL = 14.98 μg/L; RBC = 0.045 μg/L) and manganese (UTL = 776.2 μg/L; RBC = 84 μg/L). This memo examines the data and calculations involved in determining those background reference values, listed above, which exceed their corresponding risk-based standards. Possible causes of the high background values are discussed. In most cases, background reference values are recalculated and revised.

The background reference values for Zone H were the first set of such values calculated as part of the environmental investigation at NAVBASE. Three changes have since been made in the way that UTLs are calculated, to make the process more statistically sound:

- Nonparametric UTLs for small datasets are less powerful than the parametric UTLs used when detections exceed 50%, because their associated coverage is lower. For a dataset with n = 11 (such as for shallow or deep groundwater in Zone H), minimum coverage is 76.2% with 95% confidence rather than the desired 95% coverage with 95% confidence. Theoretically, this low coverage would result in a false positive rate of 24% for exceedances of the UTLs. To avoid this situation, "modified nonparametric UTLs" were originally calculated in situations where nonparametric UTLs would normally have been called for. As explained in Appendix J of the Zone H RFI Report, a modified nonparametric UTL is the mean of a parametric and a nonparametric UTL calculated from the same data. Because parametric UTLs that are based largely on estimated values for nondetects are likely to be inaccurate, modified nonparametric UTLs were not used in the recalculations in this memo. Instead, conventional nonparametric UTLs (i.e., the highest detected value) were used. The net effect of this change would generally be a lower UTL, giving lower coverage.

- Calculation of parametric UTLs involves a tolerance factor whose magnitude depends partly on the sample size. For UTLs with 95% coverage and 95% confidence, the tolerance factor for a dataset of n = 63 is 2.007; for a dataset of n = 104, the tolerance factor is 1.919. For the sake of simplicity, a tolerance factor of 2.0 was used in all of the original UTL calculations for Zone H soils. In the recalculations, a tolerance factor corresponding to the actual sample size was used. The net effect of this change would generally be to increase the UTL for lower interval soil (n = 63) and decrease it for upper interval soil (n = 104).

- The original UTLs were calculated in a two-step process, as explained in Appendix J of the RFI Report. A preliminary UTL was calculated using all of the values available, then applied to the original dataset to identify and remove "outliers." The final UTL was then calculated using the remaining values. In datasets with no natural outliers, the effect of this procedure was to remove legitimate data values inappropriately. In the recalculations, EnSafe has attempted to identify outliers in more conventional fashion, as discussed in Appendix J. Where any question existed as to whether a high value was an outlier, it was generally removed from the dataset. The net effect of this change, where it could be identified, was most often a slight increase in the UTL.

Enclosed are analytical results for all Zone H grid-based soil and groundwater samples, and histograms and normal probability plots (produced with EPA's GeoEAS program) for datasets used to calculate UTLs for inorganics in soil. Relevant EPA guidance for generic soil screening levels and associated dilution-attenuation factors as well as a table of tolerance factors for datasets of various sizes were included with the earlier package covering Zone B background values. Sample IDs that include a "C" (e.g., GDH-C-B007-01) represent field duplicates; analytical results are averaged with those of the primary sample (the "S" sample) to obtain a single value for each location. UTL calculations are discussed below. Some calculated values are slightly different from those in the Zone H report due to rounding differences.

Upper interval soil

Aluminum data values exhibit a very regular, lognormal distribution (pgs. 1a, 1b, 2a, 2b). Applying the parametric UTL formula

$$UTL = X + ks$$

where X = the sample mean, s = the sample standard deviation, and k = the tolerance factor, the preliminary UTL was calculated for a lognormal distribution as UTL = exp [8.797 + (2)(0.713)] = 27,529 mg/kg. This value was applied to the original dataset as a screen, resulting in the removal of samples GDHSB04101 (32,700 mg/kg) and GDHSB04901 (29,600 mg/kg). The final UTL was then calculated as UTL = exp [8.767 + (2)(0.686)] = 25,311 mg/kg, rounded to 25,300 mg/kg. This is a case where the two high values should not have been removed as outliers. Virtually all of the aluminum in Zone H soil appears to be present as aluminosilicate clay minerals, probably smectite and kaolinite; indeed, aluminum probably serves as an accurate gauge of clay content in the soil samples. Aluminum and iron concentrations are highly correlated in Zone H soil ($r = 0.90$ for upper interval soil grid samples; for lower interval soil grid samples, $r = 0.95$). Although iron is not a clay matrix element like aluminum, it is strongly associated with the surfaces of clay minerals. Taken together, aluminum and iron account for much of the variability of the other metals, as can be seen when crossplots are constructed for aluminum or iron vs. the trace metals. The two soil samples that were removed from the dataset were among the highest in iron as well as aluminum, indicating simply that their clay content was high. The correct UTL calculated for the original dataset (n = 104) should be UTL = exp [8.797 + (1.919)(0.713)] = 25,984 mg/kg, rounded to **26,000 mg/kg**.

The distribution of **arsenic** is strongly skewed to the right (pg. 1a), but LN-transformation overcorrected it, resulting in negative skewness (pgs. 2a, 2b). A square-root transformation provided a better approximation of normality (pgs. 3a, 3b), leading to a preliminary UTL calculation of UTL = $[2.259 + (2)(0.879)]^2$ = 16.14 mg/kg. This value was applied as a screen to the original dataset, resulting in the removal of three high values: GDHSB03401 = 17.2 mg/kg; GDHSB03501 = 17.6 mg/kg; and GDHSB04101 = 18.4 mg/kg. The reduced dataset (n = 101) was square-root transformed (pgs. 4a, 4b) and the UTL was recalculated as UTL = $[2.201 + (2)(0.823)]^2$ = 14.8 mg/kg, which was used in the RFI Report. When the three "outliers" were examined, they were found to have been collected from the same low-lying, grassy field in the eastern part of the zone. Given the possibility that the area could be contaminated, two other samples collected from the same field were removed (GDHSB03601 = 13.7 mg/kg and GDHSB04201 = 9.1 mg/kg), the dataset was again square-root transformed (pgs. 5a, 5b), and a new UTL (n = 99) was calculated as UTL = $[2.178 + (1.926)(0.813)]^2$ = 14.0 mg/kg. Further examination of the five "outliers," however, revealed that the aluminum and iron concentrations of samples 34-01, 35-01, 36-01, and 41-01 were among the very highest of the upper interval soil grid samples, as were concentrations of many other trace metals in these samples. Sample 42-01, which had been removed because of its location in the field rather than its high arsenic concentration (AS = 9.1 mg/kg, which is less than one standard deviation above the mean), exhibited much lower aluminum and iron concentrations:

Sample	AS (mg/kg)	AL (mg/kg)	FE (mg/kg)
GDHSB03401	17.2	23,400	30,900
GDHSB03501	17.6	20,200	31,800
GDHSB03601	13.7	20,700	30,300
GDHSB04101	18.4	32,700	38,800
GDHSB04201	9.1	5,760	7,460

The relationship of the aluminum and iron concentrations shown above to the overall aluminum and iron distributions can be seen on the enclosed histograms "Distribution of AL in surface soil grid samples" and "Distribution of FE in surface soil grid samples." Correlation of arsenic and aluminum concentrations among grid samples is $r = 0.69$; correlation of arsenic and iron concentrations is $r = 0.80$. The field where the five "outliers" were collected is low-lying and occasionally subject to standing water. Chemical analyses of the samples reflect high clay content, with relatively high levels of trace metals adsorbed to the surfaces of the clay particles. Since the elevated arsenic concentrations of the five samples appear to be naturally occurring, the samples were added back into the dataset and the UTL was recalculated as UTL = $[2.259 + (1.919)(0.879)]^2$ = **15.6 mg/kg**.

Beryllium concentrations are lognormally distributed (pgs. 1a, 1b, 2a, 2b). The original UTL was calculated as UTL = exp $[-1.308 + (2)(0.845)] = 1.465$ mg/kg. When this value was applied as a screen, none of the original values exceeded it, and it was used in the report. The probability plot (pg. 2b) shows that the highest values in the dataset are slightly lower than would be expected in a lognormal distribution. Of the seven samples with the highest beryllium concentrations, six also have concentrations of aluminum and iron that are among the highest in the zone:

Sample	BE (mg/kg)	AL (mg/kg)	FE (mg/kg)
GDHSB034	1.0	23,400	30,900
GDHSB036	1.1	20,700	30,300
GDHSB041	1.4	32,700	38,800
GDHSB049	1.2	29,600	32,200
GDHSB068	1.0	5,850	8,100
GDHSB079	1.2	26,600	28,100
GDHSB090	1.2	22,300	36,700

Three of the seven samples shown above (34-01, 36-01, and 41-01) were among the five potential outliers for arsenic. Because the highest beryllium concentrations detected in the samples are considered to be naturally occurring, the UTL was recalculated only to correct the tolerance factor, as follows: UTL = exp [-1.308 + (1.919)(0.845)] = 1.368 mg/kg, rounded to **1.37 mg/kg**.

The **chromium** distribution is also positively skewed (pgs. 1a, 1b), and it was LN-transformed (pgs. 2a, 2b). The preliminary UTL was calculated as UTL = exp [2.951 + (2)(0.799)] = 94.54 mg/kg. When this value was applied as a screen, two data points (GDHSB08601 = 114 mg/kg; GDHSB08701 = 107 mg/kg) were removed, and the final UTL for n = 102 was calculated as UTL = exp [2.916 + (2)(0.767)] = 85.63 mg/kg (pgs. 4a, 4b). The relationship of chromium to aluminum and iron in samples with high chromium concentrations is as follows:

Sample	CR (mg/kg)	AL (mg/kg)	FE (mg/kg)
GDHSB03501	55.5	20,200	31,800
GDHSB01501	56.9	5,880	6,830
GDHSB04101	57.0	32,700	38,800
GDHSB04901	61.8	29,600	32,200
GDHSB07501	63.5	8,180	8,640
GDHSB08501	63.8	8,550	7,830
GDHSB07901	65.6	26,600	28,100
GDHSB09001	87.6	22,300	36,700
GDHSB08701	107	10,800	9,090
GDHSB08601	114	4,400.	5,970

Although the prominence of samples with unusually high levels of aluminum and iron is apparent in the table above, the argument for naturally occurring chromium is not as strong as that for arsenic and beryllium because correlations with the two normalizing metals are lower. Chromium correlates with both aluminum and iron at $r = 0.58$. Based on conventional criteria for identifying outliers, three samples have now been removed from the original dataset: the two formerly removed, plus GDHSB09001 (87.6 mg/kg). A new UTL based on a LN-transformation would be UTL = exp [2.901 + (1.923)(0.755)] = 77.7 mg/kg; the new UTL based on a square-root transformation would be UTL = $[4.56 + (1.923)(1.625)]^2$ = **59.1 mg/kg**. The square-root transformation is preferred because of lower skewness and kurtosis, as well as a more regular box and whisker plot.

The distribution of **manganese** values is strongly skewed to the right (pg. 1a), and remains slightly skewed in a positive direction after being LN-transformed (pg.2a). The preliminary UTL was calculated as UTL = exp [4.282 + (2)(1.167)] = 747 mg/kg. When this value was applied as a screen, two values were removed: GDHSB04201 (1,200 mg/kg) and GDHSB04101 (983 mg/kg). The calculated UTL for the reduced dataset of n = 102 was UTL = exp [4.229 + (2)(1.114)] = 637 mg/kg. The two values that were removed both represented samples from the open field that was the source of the arsenic "outliers" discussed above. The three samples next lowest in manganese (79-01 = 597 mg/kg; 34-01 = 589 mg/kg; and 90-01 = 518 mg/kg) are all among the group previously identified as being high in aluminum and iron, and therefore probably clay-rich. Manganese is correlated with aluminum at $r = 0.64$; it is correlated with iron at $r = 0.70$. The two samples that were removed originally (41-01 and 42-01) have now been identified as outliers based on conventional criteria (pgs. 3a, 3b, 4a, 4b), and the UTL has been recalculated to reflect a more accurate tolerance factor: UTL = exp [4.229 + (1.921)(1.114)] = **583 mg/kg**.

The reported UTL for **thallium** is nonparametric because thallium was detected in only 10 of 104 samples. With a sample size of 104, a UTL with 95% coverage and 95% confidence is best approximated by using the second highest value, which is 1.1 mg/kg. This value was applied as a screen to remove the two highest original values, leaving 0.63 mg/kg as the second highest value in the reduced dataset. As discussed earlier, there is no statistical justification for removing data values from the background dataset unless they are identified as conventional outliers. Therefore, the nonparametric UTL for thallium should be **1.1 mg/kg**, which is the second highest value in the original dataset.

As with the other trace metals, the **vanadium** distribution is strongly skewed to the right (pgs. 1a, 1b). Both LN-transformation (pgs. 2a, 2b) and square-root transformation (pgs. 3a, 3b) were performed, with the LN-transformation considered a better approximation of normality by all criteria. The preliminary UTL was calculated as UTL = exp [2.889 + (2)(0.730)] = 77.4 mg/kg. When this value was applied as a screen, none of the original data values was eliminated, and it was used in the report. The seven highest vanadium detections (41-01 = 74.8 mg/kg; 90-01 = 71.7 mg/kg; 35-01 = 69.1 mg/kg; 49-01 = 68.3 mg/kg; 79-01 = 66.5 mg/kg; 34-01 = 60.1 mg/kg; 36-01 = 55.5 mg/kg) came from the samples that also reported the seven highest concentrations of both aluminum and iron, indicating a natural origin for the vanadium. Correlation of vanadium and aluminum is $r = 0.89$; correlation of vanadium and iron is $r = 0.90$. The UTL has been recalculated to reflect a more accurate tolerance factor: UTL = exp [2.889 + (1.919)(0.730)] = **73.0 mg/kg**.

Lower interval soil

Initial examination of the **arsenic** dataset revealed an obvious outlier for both original (pgs. 1a, 1b) and transformed (2a, 2b) data values. A preliminary UTL was calculated as UTL = exp [1.767 + (2)(1.004)] = 43.6 mg/kg and used as a screen to remove sample GDHSB04302 (136 mg/kg) from the dataset. The outlier sample was collected from a landscaped area next to barracks Building 676, WNW of SWMU 14; the corresponding upper interval soil sample reported 5.2 mg/kg AS. For the reduced dataset (n = 62), a final UTL was calculated as UTL = exp [1.716 + (2)(0.927)] = 35.5 mg/kg (pgs. 4a, 4b, 4c), which was used in the report. The samples with the highest arsenic concentrations, including 43-02 (the outlier) were also high in both aluminum and iron:

Sample	AS (mg/kg)	AL (mg/kg)	FE (mg/kg)
GDHSB04302	136	45,300	44,600
GDHSB08202	28.3	41,400	54,300
GDHSB04002	22.8	19,100	34,900
GDHSB03402	22.3	31,700	46,800
GDHSB04602	20.3	31,100	40,400
GDHSB04502	19.1	34,600	40,600
GDHSB01502	18.5	19,600	33,600
GDHSB03902	18.3	32,600	30,000

Arsenic correlated with aluminum at $r = 0.87$, and with iron at $r = 0.92$. For the current study, data values were square-root transformed, which yielded a closer approximation to a normal distribution than the LN-transformation. A new UTL was calculated as $UTL = [2.594 + (2.01)(1.07)]^2 =$ **22.5 mg/kg.**

Chromium was evaluated as original values (pgs.1a, 1b), LN-transformed values (pgs. 2a, 2b), and square-root transformed values (pgs. 3a, 3b). A preliminary UTL based on the square-root transformation was calculated as $UTL = [5.21 + (2)(2.077)]^2 = 87.7$ mg/kg. When this value was used as a screen, sample GDHSB08602 (95.2 mg/kg) was removed from the dataset. A UTL based on the reduced dataset (n = 62) and the square-root transformation (pgs. 6a, 6b) was calculated as $UTL = [5.136 + (2)(2.011)]^2 = 83.9$ mg/kg, which was used in the report. The outlier sample, 86-02, was collected from a grassy field near the edge of a wooded area, near the parking lot around barracks Building 668 in the southern part of the zone. The sampling location had been relocated several feet after the initial boring turned up a small amount of mixed trash. The upper interval soil sample from the same location reported 114 mg/kg chromium, which was the highest chromium concentration of any Zone H grid-based soil sample. None of the 135 Zone H soil samples analyzed for hexachrome reported a detection. Sample 86-02, the outlier, was low in aluminum (4,520 mg/kg) and iron (5,920 mg/kg). Other samples that were high in chromium had varied levels of the two normalizing metals:

Sample	CR (mg/kg)	AL (mg/kg)	FE (mg/kg)
GDHSB03902	72.6	32,600	30,000
GDHSB08202	72.1	41,400	54,300
GDHSB04302	68.6	45,300	44,600
GDHSB01202	64.9	4,810	4,540
SGCSB00202	64.2	4,660	4,380
GDHSB00302	61.8	5,770	5,730

Chromium correlated with aluminum at $r = 0.58$ and with iron ar $r = 0.55$. On reexamination, sample 86-02 remained as the only outlier, based on conventional criteria, and the UTL was recalculated to reflect a more accurate tolerance factor: UTL = [5.136 + (2.01)(2.011)] = **84.2 mg/kg**.

Thallium was detected in only 9 of 63 samples, at concentrations ranging from 0.36 mg/kg to 1.9 mg/kg (in GDHSB04502). The second highest value serves as the nonparametric UTL: **1.3 mg/kg** (in GDHSB03902).

VCHEM_R ENVIRONMENTAL SAFETY & DESIGNS Page: 1
01/28/97 2902-00001 - CHARLESTON ZONE B - SOIL & 1ST GW Time: 09:22

Samples by Chemical Report
7440-38-2 - Arsenic (As)
>= 0.0000 for MG/KG

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDB-S-B008-02		GDBSB00802	Soil	10/04/95	0.8300	U	MG/KG	L5540S	VAL
GDB-S-B004-02		GDBSB00402	Soil	10/04/95	0.8400	U	MG/KG	L5540S	VAL
GDB-S-B015-01		GDBSB01501	Soil	10/04/95	0.8900	U	MG/KG	L5540S	VAL
GDB-S-B015-02		GDBSB01502	Soil	10/04/95	0.9200	U	MG/KG	L5540S	VAL
507-S-B001-02		507SB00102	Soil	10/04/95	0.9400	U	MG/KG	L5540S	VAL
507-S-B002-02		507SB00202	Soil	10/04/95	0.9600	U	MG/KG	L5540S	VAL
GDB-S-B005-02		GDBSB00502	Soil	10/04/95	0.9600	U	MG/KG	L5540S	VAL
507-S-B004-02		507SB00402	Soil	10/04/95	1.1000	J	MG/KG	L5540S	VAL
507-S-B003-02		507SB00302	Soil	10/04/95	1.2000	J	MG/KG	L5540S	VAL
GDB-S-B009-02		GDBSB00902	Soil	10/04/95	1.2000	J	MG/KG	L5540S	VAL
507-S-B005-02		507SB00502	Soil	10/04/95	1.4000	J	MG/KG	L5540S	VAL
507-S-B005-01		507SB00501	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B004-01		GDBSB00401	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B012-02		GDBSB01202	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B014-02		GDBSB01402	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B008-01		GDBSB00801	Soil	10/04/95	2.0000	J	MG/KG	L5540S	VAL
GDB-C-B008-01		GDBCB00801	Soil	10/04/95	2.0000	J	MG/KG	L5530S	VAL
GDB-S-B012-01		GDBSB01201	Soil	10/04/95	2.1000	J	MG/KG	L5540S	VAL
507-S-B001-01		507SB00101	Soil	10/04/95	3.0000	J	MG/KG	L5540S	VAL
507-S-B004-01		507SB00401	Soil	10/04/95	3.4000		MG/KG	L5540S	VAL
GDB-S-B007-02		GDBSB00702	Soil	10/04/95	3.4000		MG/KG	L5540S	VAL
GDB-S-B014-01		GDBSB01401	Soil	10/04/95	3.5000		MG/KG	L5540S	VAL
GDB-S-B006-02		GDBSB00602	Soil	10/04/95	3.8000		MG/KG	L5540S	VAL
GDB-S-B006-01		GDBSB00601	Soil	10/04/95	4.0000		MG/KG	L5540S	VAL
GDB-S-B009-01		GDBSB00901	Soil	10/04/95	4.2000		MG/KG	L5540S	VAL
507-C-B004-01		507CB00401	Soil	10/04/95	4.3000		MG/KG	L5530S	VAL
507-S-B002-01		507SB00201	Soil	10/04/95	4.7000		MG/KG	L5540S	VAL
GDB-S-B010-02		GDBSB01002	Soil	10/04/95	4.7000		MG/KG	L5540S	VAL
GDB-S-B005-01		GDBSB00501	Soil	10/04/95	5.3000		MG/KG	L5540S	VAL
507-S-B003-01		507SB00301	Soil	10/04/95	5.4000		MG/KG	L5540S	VAL
GDB-S-B007-01		GDBSB00701	Soil	10/04/95	6.5000		MG/KG	L5540S	VAL
GDB-S-B010-01		GDBSB01001	Soil	10/04/95	6.7000		MG/KG	L5540S	VAL
→ GDB-S-B003-01		GDBSB00301	Soil	10/04/95	9.0000		MG/KG	L5540S	VAL
GDB-S-B013-02		GDBSB01302	Soil	10/04/95	10.8000		MG/KG	L5540S	VAL
→ GDB-S-B011-02		GDBSB01102	Soil	10/04/95	11.7000		MG/KG	L5540S	VAL
→ GDB-S-B001-01		GDBSB00101	Soil	10/04/95	12.3000		MG/KG	L5540S	VAL
GDB-S-B013-01		GDBSB01301	Soil	10/04/95	12.3000		MG/KG	L5540S	VAL
→ GDB-S-B002-02		GDBSB00202	Soil	10/04/95	15.8000		MG/KG	L5540S	VAL
→ GDB-S-B002-01		GDBSB00201	Soil	10/04/95	22.1000		MG/KG	L5540S	VAL
→ GDB-C-B001-01		GDBCB00101	Soil	10/04/95	26.9000		MG/KG	L5530S	VAL
→ GDB-S-B011-01		GDBSB01101	Soil	10/04/95	28.7000		MG/KG	L5540S	VAL
→ GDB-S-B001-02		GDBSB00102	Soil	10/04/95	33.9000		MG/KG	L5540S	VAL

*** End of Report ***

→ Grid sample collected on golf course

Sample results listed in order of concentration

Zone B: Arsenic in surface soil grid samples 2/5/97

The calculated UTL for arsenic in surface soil grid samples in Zone B is 90.0 mg/kg, based on the dataset of 15 samples collected at grid locations in the zone. Because the Zone B arsenic UTL is high compared to those of other zones, SCDHEC requested that EnSafe reexamine the locations of the soil grid samples vs. the analytical results. Four of the 15 soil grid sample locations fell in the golf course that makes up a large part of the zone. Arsenic concentrations in the surface soil samples from these locations represent four of the five highest arsenic levels measured in surface soils in the zone:

GDBSB00101	19.6 mg/kg (combined "S" [12.3] and "C" [26.9] concentrations)
GDBSB00201	22.1 mg/kg
GDBSB00301	9.0 mg/kg
GDBSB01101	28.7 mg/kg

Because arsenates are common constituents of herbicides that may have been applied to the golf course in the past, the somewhat elevated levels of arsenic in surface soil samples from the golf course may reflect past applications. AOC 507, the only site in Zone B, is near but not a part of the golf course, and the arsenic concentrations of its surface soil samples are more typical of levels seen in grid samples collected away from the course. Since arsenic concentrations in the soil of the golf course may not be representative of background conditions that apply to the site, the four surface soil samples that were collected on the golf course were removed from the arsenic dataset and an alternate UTL was calculated using the 11 remaining sample results. After performing a square-root transformation of the data (the original dataset was log-transformed), the new UTL was determined to be 17.1 mg/kg.

Attached is a copy of a printout with analytical results for arsenic in all soil samples collected in Zone B, in order of concentration. Surface and subsurface results for the four golf course samples are highlighted.

MEMO 3-3-97

TO: Project Team members
FROM: EnSafe

RE: Summary of dataset adjustments, data transformations, and calculations used to obtain background reference values for Zone B

Because datasets for grid-based soil samples in Zone B were large enough to allow computation of statistically based background reference values (n =15 for upper interval soil; n =14 for lower interval soil), upper tolerance limits (UTLs) with 95%coverage and 95% confidence were calculated for inorganics in soil. Background reference values were not calculated for inorganics in groundwater because groundwater was not sampled at AOC 507, which was the only site investigated in Zone B. As reported in a table dated 2-14-97 and faxed to the Project Team members following the February Team meeting, calculated background reference values for Zone B exceeded RBCs for upper interval soil for aluminum (UTL = 15,500 mg/kg; RBC = 7,800 mg/kg), arsenic (UTL = 17.1 mg/kg; RBC = 0.43 mg/kg), beryllium (UTL = 1.34 mg/kg; RBC = 0.15 mg/kg), chromium (UTL = 80.2 mg/kg; hexachrome RBC = 39 mg/kg), manganese (UTL = 589 mg/kg; RBC = 180 mg/kg), and vanadium (UTL = 156 mg/kg; RBC = 55 mg/kg). For lower interval soil, calculated UTLs exceeded generic soil screening levels (SSLs) for arsenic (UTL = 48.9 mg/kg; SSL = 29 mg/kg) and chromium (UTL = 75.7 mg/kg; hexachrome SSL = 38 mg/kg).

As discussed in a memo distributed at the February Project Team meeting ("Zone B: Arsenic in surface soil grid samples," dated 2-5-97), the UTL for arsenic in upper interval soil was earlier lowered from 90.0 mg/kg to 17.1 mg/kg as a result of removing four grid samples (GDBSB00101, GDBSB00201, GDBSB00301, and GDBSB01101) from the arsenic dataset. They were removed because they had all been collected from the golf course portion of the zone, and were felt to have been influenced by possible past applications of herbicides containing arsenates. Two of the four sample locations (GDBSB001 and GDBSB002) fell in the portion of the zone known to consist of fill material. Examination of analytical results for these two sample locations showed that reported concentrations of inorganics were consistently higher than for other grid-based samples for both upper and lower interval soil, and they have consequently been dropped from the soil datasets for all inorganics as being unrepresentative of conditions in the rest of the zone. Calculations included in this package show results for both the original and reduced datasets.

Enclosed are analytical results for all Zone B grid-based soil samples; relevant EPA guidance for generic soil screening levels and associated dilution-attenuation factors; a table of tolerance factors for datasets of various sizes; and histograms and normal probability plots (produced with EPA's GeoEAS program) for datasets used to calculate UTLs for inorganics in soil. Sample IDs that include a "C" (e.g., GDB-C-B008-01) represent field duplicates; analytical results are averaged with those of the primary sample to obtain a single value for each location. UTL calculations are discussed below.

Upper interval soil

The **aluminum** dataset for upper interval soil had one outlier (GDBSB01101) in addition to the two discussed above. After all three were removed, original data values (rather than transformed values) of the remaining samples represented the closest approximation to a normal distribution (pgs. 3a, 3b). The UTL is obtained by calculating

$$UTL = X + ks$$

where X = the sample mean, s = the sample standard deviation, and k = the tolerance factor (see enclosed table). In this case, the UTL equals [9714 + (2.736)(2126)] = 15,531 mg/kg, or 15,500 mg/kg when rounded to three significant figures.

Enclosed **arsenic** materials include the February 5 memo concerning reduction of the UTL from 90.0 to 17.1 mg/kg, zonewide soil concentrations, and a map of sample locations. After removal of the four outliers, a square-root transformation (pgs. 5a, 5b) produced the closest approximation to normality based on skewness, kurtosis, coefficient of variation, box and whisker plot, and normal probability plot.* $UTL = [1.973 + (2.815)(0.769)]^2 = 17.1$ mg/kg.

The two deleted outlier samples represented the two highest concentrations in the **beryllium** dataset. After their removal, the square-root transformation (pgs 5a, 5b) provided a somewhat better approximation of normality than original values. $UTL = [0.632 + (2.670)(0.179)]^2 = 1.23$ mg/kg.

After removal of the two outlier samples from the **chromium** dataset, the LN-transformation (pgs. 4a, 4b) produced a much better approximation of normality than original data values. Because skewness was still positive after the LN-transformation, a square-root transformation was not attempted. The square-root transformation generally yields skewness roughly midway between those of original data and LN-transformed data. UTL = exp[2.711 + (2.670)(0.605)] = 75.7 mg/kg. Also included in the package are analytical results for Zone B soil samples analyzed for total chromium (all soil samples) and hexavalent chromium (three field duplicates only); hexavalent chromium was detected in one of three samples, at a concentration of 0.3 mg/kg.

After removal of the two high outliers, a normal distribution of **manganese** was best represented by the original data values (pgs. 3a, 3b). UTL = 178.9 + (2.670)(106.7) = 464 mg/kg.

As with all of the inorganic datasets, the two removed outlier samples reported the highest concentrations of **vanadium** in upper interval soil. After their removal, the LN-transformation (pgs. 4a, 4b) gave the closest approximation to a normal distribution for a dataset of n = 13. Although removal of an additional high data value (51.6 mg/kg at GDBSB01101) combined with LN-transformation produced a somewhat closer approximation to normality (pgs. 6a, 6b), this approach was rejected because the normal probability plot (pg. 6b) revealed an S-shaped curve that is characteristic of excessive trimming of the dataset. For the dataset illustrated on pg. 4a, UTL = exp[2.653 + (2.670)(0.630)] = 76.3 mg/kg.

Revised UTLs for upper interval soil, based on the trimmed dataset of n = 13, are as follows:

Aluminum	15,500 mg/kg
Arsenic	17.1 mg/kg
Beryllium	1.23 mg/kg
Chromium	75.7 mg/kg
Manganese	464 mg/kg
Vanadium	76.3 mg/kg

Lower interval soil

After removal of samples GDBSB00102 and GDBSB00202 as outliers, the dataset for **arsenic** was still skewed strongly to the right (pg. 3a). LN-transformation of the data yielded a distribution closer to normal, except for the four nondetect values on the left side of the histogram (pg. 4a). It is possible that the estimates of the nondetects are too low in this case (pg. 4b). Since the overall distribution is far from that of the bell-shaped curve of a normal distribution, a nonparametric UTL will be used in this instance: UTL = maximum detected value = 11.7 mg/kg.

The reduced dataset for **chromium** is also skewed strongly to the right (pg. 3a), and remains positively skewed after LN-transformation (pg. 4a). A calculated UTL based on the transformed data would be: $UTL = \exp[2.065 + (2.736)(0.956)] = 108$ mg/kg. This is an example of a somewhat inflated UTL due to the combination of a small dataset and a strongly skewed distribution. Under the circumstances, a nonparametric UTL might be more appropriate: UTL = maximum detected value = 48.1 mg/kg.

Revised UTLs for lower interval soil, based on the trimmed dataset of n = 12, are as follows:

Arsenic	11.7 mg/kg
Chromium	48.1 mg/kg

* The Texas Natural Resources Conservation Commission (TNRCC) mandates use of the Shapiro-Wilk test of normality for background datasets in projects under its jurisdiction. It has been EnSafe's experience that the Shapiro-Wilk test is too forgiving; that is, the test is too quick to find a dataset normally distributed when it is obviously not. For this reason, the Shapiro-Wilk test was not run on Zone B datasets.

Zone B: Arsenic in surface soil grid samples 2/5/97

The calculated UTL for arsenic in surface soil grid samples in Zone B is 90.0 mg/kg, based on the dataset of 15 samples collected at grid locations in the zone. Because the Zone B arsenic UTL is high compared to those of other zones, SCDHEC requested that EnSafe reexamine the locations of the soil grid samples vs. the analytical results. Four of the 15 soil grid sample locations fell in the golf course that makes up a large part of the zone. Arsenic concentrations in the surface soil samples from these locations represent four of the five highest arsenic levels measured in surface soils in the zone:

GDBSB00101	19.6 mg/kg (combined "S" [12.3] and "C" [26.9] concentrations)
GDBSB00201	22.1 mg/kg
GDBSB00301	9.0 mg/kg
GDBSB01101	28.7 mg/kg

Because arsenates are common constituents of herbicides that may have been applied to the golf course in the past, the somewhat elevated levels of arsenic in surface soil samples from the golf course may reflect past applications. AOC 507, the only site in Zone B, is near but not a part of the golf course, and the arsenic concentrations of its surface soil samples are more typical of levels seen in grid samples collected away from the course. Since arsenic concentrations in the soil of the golf course may not be representative of background conditions that apply to the site, the four surface soil samples that were collected on the golf course were removed from the arsenic dataset and an alternate UTL was calculated using the 11 remaining sample results. After performing a square-root transformation of the data (the original dataset was log-transformed), the new UTL was determined to be 17.1 mg/kg.

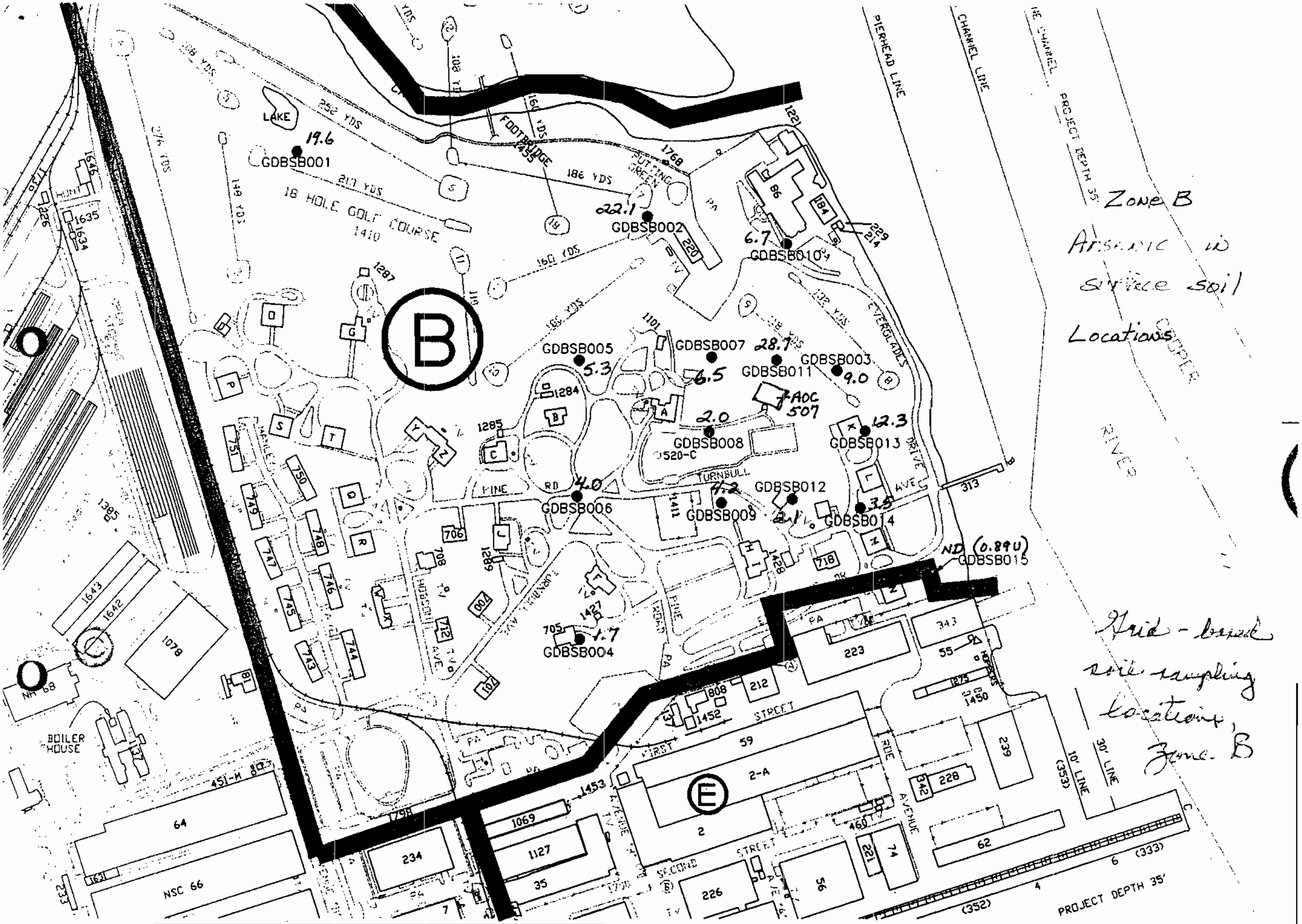
Attached is a copy of a printout with analytical results for arsenic in all soil samples collected in Zone B, in order of concentration. Surface and subsurface results for the four golf course samples are highlighted.

ENVIRONMENTAL SAFETY & DESIGNS
2902-00001 - CHARLESTON ZONE B - SOIL & 1ST GW
Samples by Chemical Report
7440-38-2 - $\boxed{\text{Arsenic (As)}}$
>= 0.0000 for MG/KG

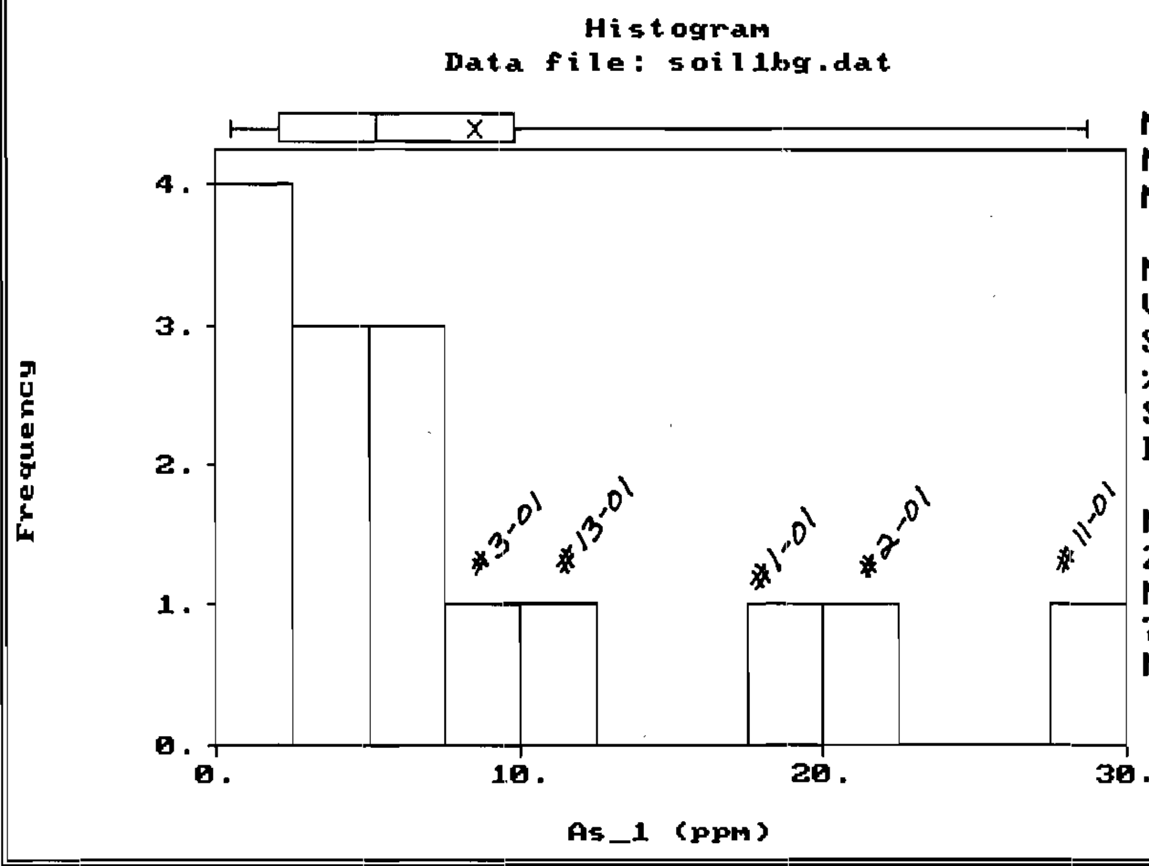
Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDB-S-B008-02	GDBSB00802	Soil	10/04/95	0.8300	U	MG/KG	L5540S	VAL
GDB-S-B004-02	GDBSB00402	Soil	10/04/95	0.8400	U	MG/KG	L5540S	VAL
GDB-S-B015-01	GDBSB01501	Soil	10/04/95	0.8900	U	MG/KG	L5540S	VAL
GDB-S-B015-02	GDBSB01502	Soil	10/04/95	0.9200	U	MG/KG	L5540S	VAL
507-S-B001-02	507SB00102	Soil	10/04/95	0.9400	U	MG/KG	L5540S	VAL
507-S-B002-02	507SB00202	Soil	10/04/95	0.9600	U	MG/KG	L5540S	VAL
GDB-S-B005-02	GDBSB00502	Soil	10/04/95	0.9600	U	MG/KG	L5540S	VAL
507-S-B004-02	507SB00402	Soil	10/04/95	1.1000	J	MG/KG	L5540S	VAL
507-S-B003-02	507SB00302	Soil	10/04/95	1.2000	J	MG/KG	L5540S	VAL
GDB-S-B009-02	GDBSB00902	Soil	10/04/95	1.2000	J	MG/KG	L5540S	VAL
507-S-B005-02	507SB00502	Soil	10/04/95	1.4000	J	MG/KG	L5540S	VAL
507-S-B005-01	507SB00501	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B004-01	GDBSB00401	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B012-02	GDBSB01202	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B014-02	GDBSB01402	Soil	10/04/95	1.7000	J	MG/KG	L5540S	VAL
GDB-S-B008-01	GDBSB00801	Soil	10/04/95	2.0000	J	MG/KG	L5540S	VAL
GDB-C-B008-01	GDBCB00801	Soil	10/04/95	2.0000	J	MG/KG	L5530S	VAL
GDB-S-B012-01	GDBSB01201	Soil	10/04/95	2.1000	J	MG/KG	L5540S	VAL
507-S-B001-01	507SB00101	Soil	10/04/95	3.0000	J	MG/KG	L5540S	VAL
507-S-B004-01	507SB00401	Soil	10/04/95	3.4000		MG/KG	L5540S	VAL
GDB-S-B007-02	GDBSB00702	Soil	10/04/95	3.4000		MG/KG	L5540S	VAL
GDB-S-B014-01	GDBSB01401	Soil	10/04/95	3.5000		MG/KG	L5540S	VAL
GDB-S-B006-02	GDBSB00602	Soil	10/04/95	3.8000		MG/KG	L5540S	VAL
GDB-S-B006-01	GDBSB00601	Soil	10/04/95	4.0000		MG/KG	L5540S	VAL
GDB-S-B009-01	GDBSB00901	Soil	10/04/95	4.2000		MG/KG	L5540S	VAL
507-C-B004-01	507CB00401	Soil	10/04/95	4.3000		MG/KG	L5530S	VAL
507-S-B002-01	507SB00201	Soil	10/04/95	4.7000		MG/KG	L5540S	VAL
GDB-S-B010-02	GDBSB01002	Soil	10/04/95	4.7000		MG/KG	L5540S	VAL
GDB-S-B005-01	GDBSB00501	Soil	10/04/95	5.3000		MG/KG	L5540S	VAL
507-S-B003-01	507SB00301	Soil	10/04/95	5.4000		MG/KG	L5540S	VAL
GDB-S-B007-01	GDBSB00701	Soil	10/04/95	6.5000		MG/KG	L5540S	VAL
GDB-S-B010-01	GDBSB01001	Soil	10/04/95	6.7000		MG/KG	L5540S	VAL
→ GDB-S-B003-01	GDBSB00301	Soil	10/04/95	9.0000		MG/KG	L5540S	VAL
GDB-S-B013-02	GDBSB01302	Soil	10/04/95	10.8000		MG/KG	L5540S	VAL
→ GDB-S-B011-02	GDBSB01102	Soil	10/04/95	11.7000		MG/KG	L5540S	VAL
→ GDB-S-B001-01	GDBSB00101	Soil	10/04/95	12.3000		MG/KG	L5540S	VAL
GDB-S-B013-01	GDBSB01301	Soil	10/04/95	12.3000		MG/KG	L5540S	VAL
→ GDB-S-B002-02	GDBSB00202	Soil	10/04/95	15.8000		MG/KG	L5540S	VAL
→ GDB-S-B002-01	GDBSB00201	Soil	10/04/95	22.1000		MG/KG	L5540S	VAL
→ GDB-C-B001-01	GDBCB00101	Soil	10/04/95	26.9000		MG/KG	L5530S	VAL
→ GDB-S-B011-01	GDBSB01101	Soil	10/04/95	28.7000		MG/KG	L5540S	VAL
→ GDB-S-B001-02	GDBSB00102	Soil	10/04/95	33.9000		MG/KG	L5540S	VAL

*** End of Report ***

→ Grid sample collected on golf course
Sample results listed in order of concentration

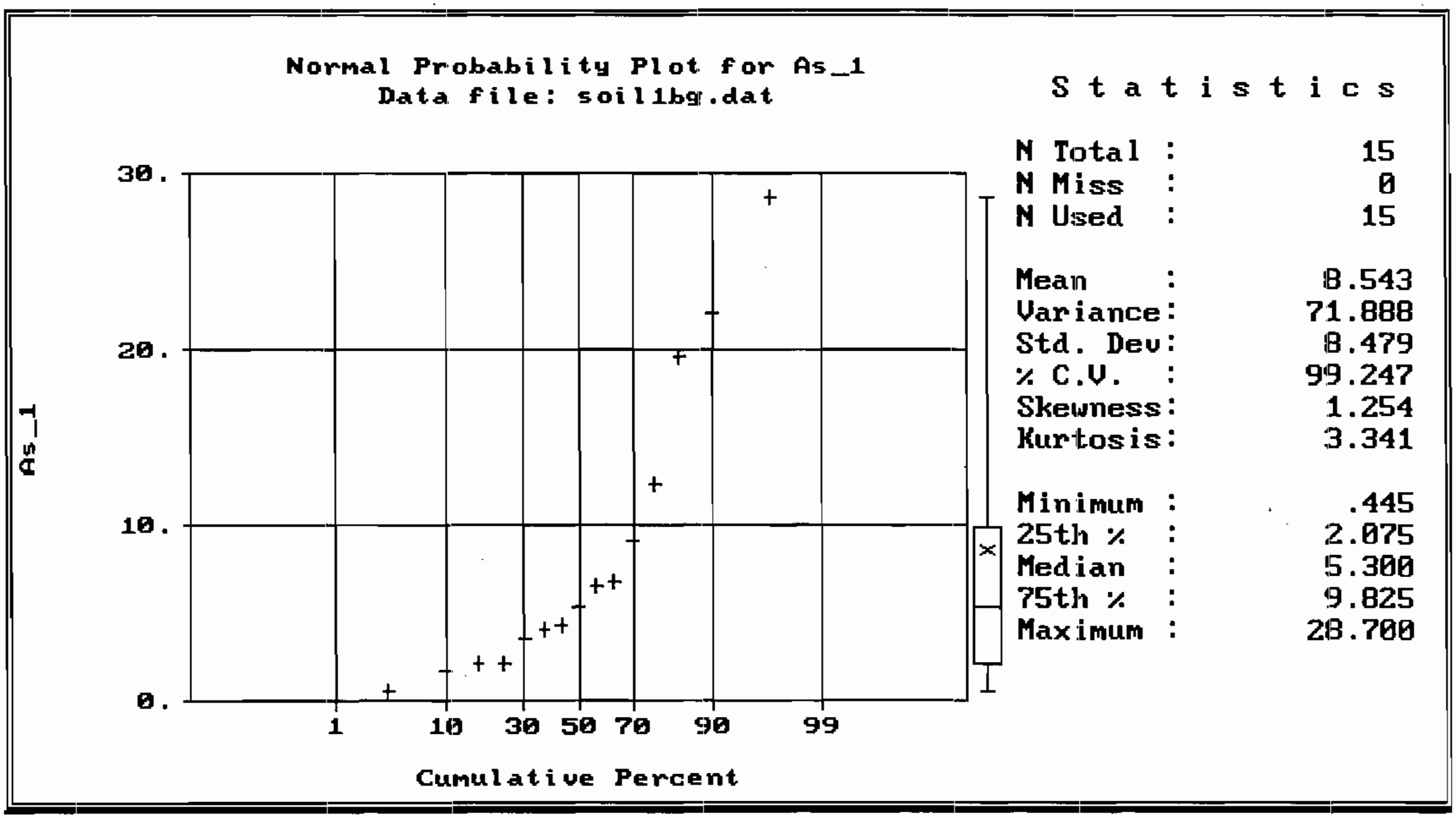

Zone B
Arsenic in surface soil
Locations
Grid-based soil sampling locations, Zone B
B
E
19.6
GDBSB001
22.1
GDBSB002
GDBSB003
9.0
GDBSB004
1.7
GDBSB005
5.3
GDBSB006
4.0
GDBSB007
6.5
GDBSB008
2.0
GDBSB009
GDBSB010
6.7
GDBSB011
28.7
GDBSB012
GDBSB013
12.3
GDBSB014
ND (0.89U)
GDBSB015
AOC 507
18 HOLE GOLF COURSE
1410
LAKE
FOOTBRIDGE
PUTTING GREEN
PIERHEAD LINE
CHANNEL LINE
PROJECT DEPTH 35'
COOPER RIVER
BOILER HOUSE
PINE RD
TURNBULL AVE
EVERGLADES DRIVE
FIRST STREET
SECOND STREET
HOBSON AVE
NSC 66
30' LINE
10' LINE

Zone B
AS in surface soil grid samples
Original dataset (N=15)
Original values

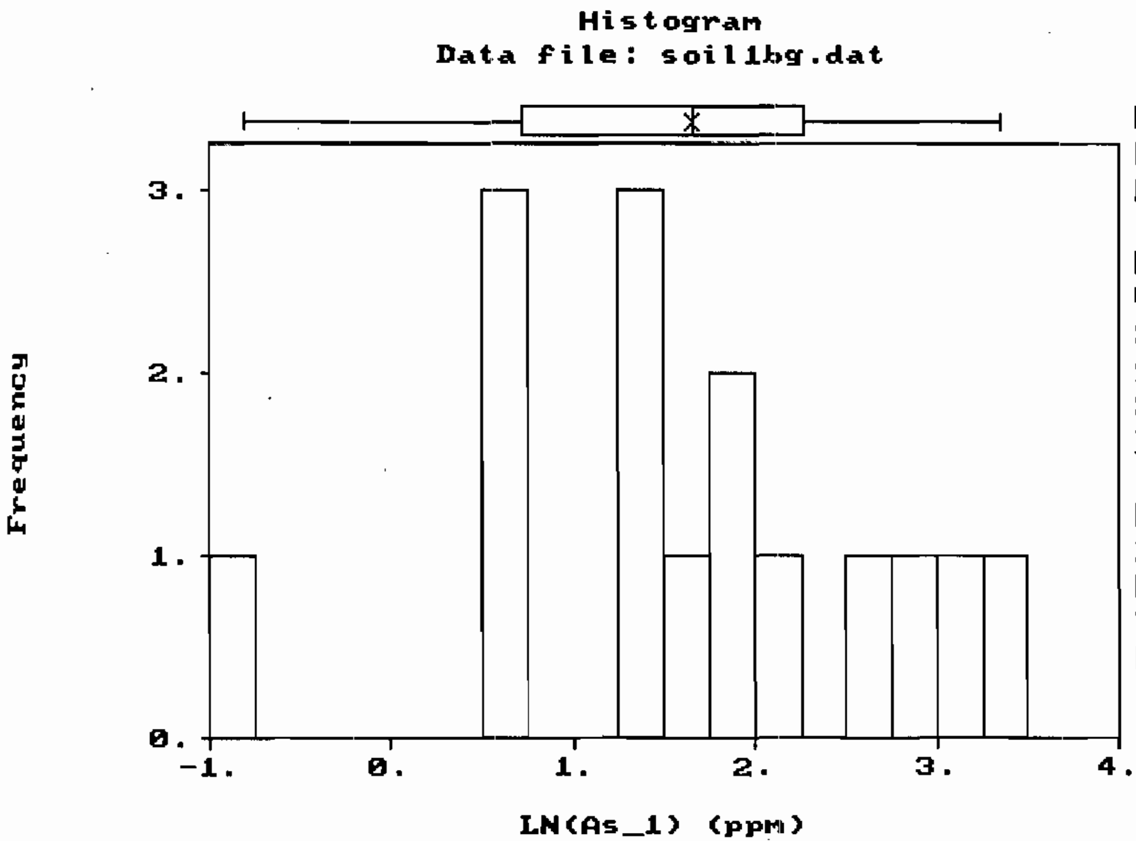


Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	8.543
Variance:	71.888
Std. Dev:	8.479
% C.V. :	99.247
Skewness:	1.254
Kurtosis:	3.341
Minimum :	.445
25th % :	2.075
Median :	5.300
75th % :	9.825
Maximum :	28.700

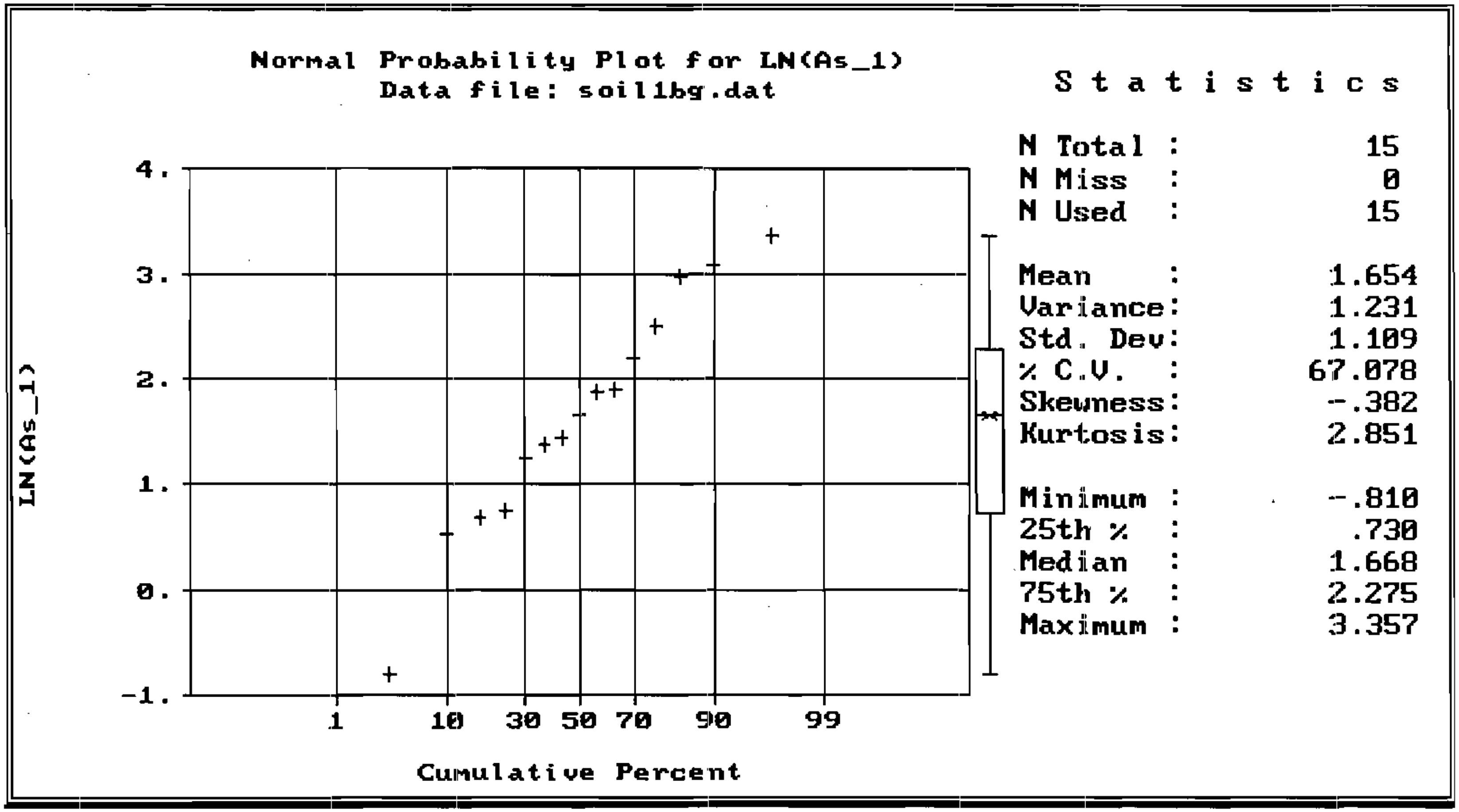

Normal Probability Plot for As_1
Data file: soil1bg.dat
30.
20.
10.
0.
As_1
1
10
30
50
70
90
99
Cumulative Percent
Statistics
N Total : 15
N Miss : 0
N Used : 15
Mean : 8.543
Variance: 71.888
Std. Dev: 8.479
% C.V. : 99.247
Skewness: 1.254
Kurtosis: 3.341
Minimum : .445
25th % : 2.075
Median : 5.300
75th % : 9.825
Maximum : 28.700

Zone B
Arsenic in surface soil grid samples
Original dataset (N = 15)
LN-transformed data

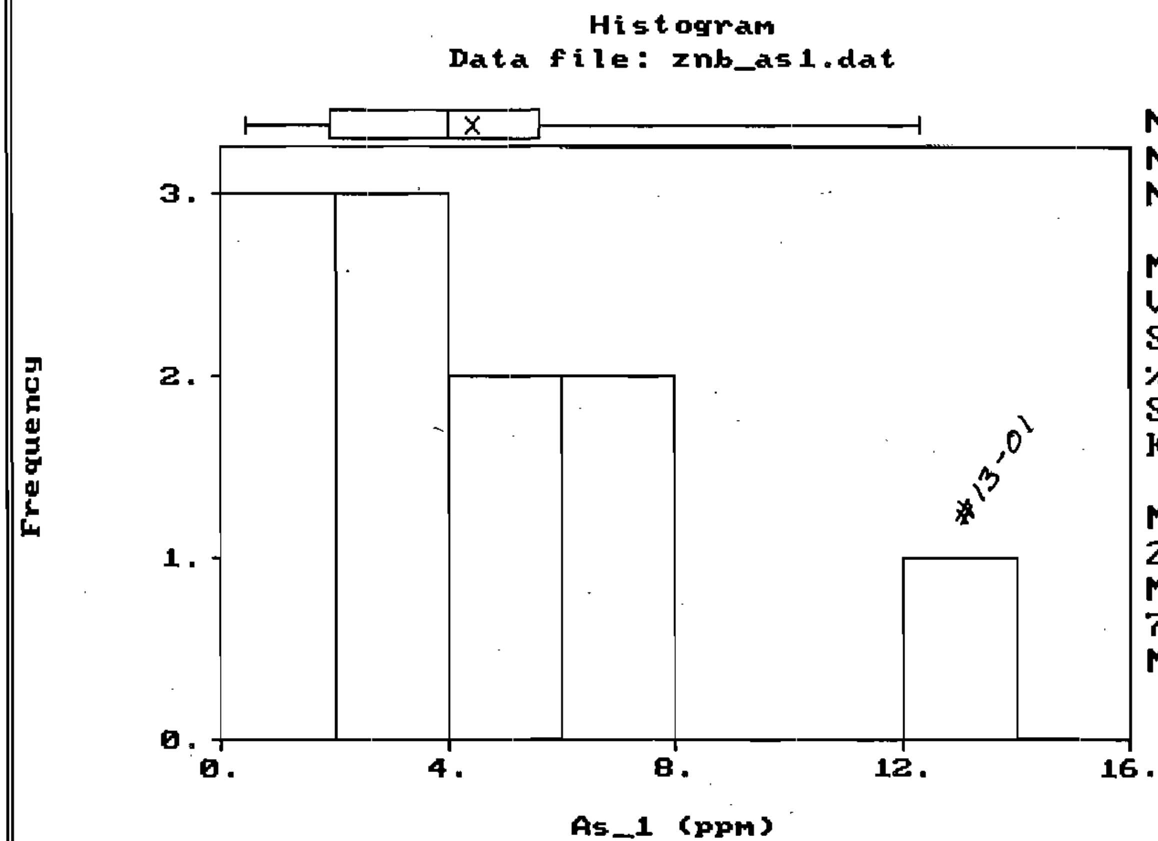


Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	1.654
Variance:	1.231
Std. Dev:	1.109
% C.V. :	67.078
Skewness:	-.382
Kurtosis:	2.851
Minimum :	-.810
25th % :	.730
Median :	1.668
75th % :	2.275
Maximum :	3.357


Normal Probability Plot for LN(As_1)
Data file: soil1bg.dat
LN(As_1)
4.
3.
2.
1.
0.
-1.
1
10
30
50
70
90
99
Cumulative Percent
S t a t i s t i c s
N Total : 15
N Miss : 0
N Used : 15
Mean : 1.654
Variance: 1.231
Std. Dev: 1.109
% C.V. : 67.078
Skewness: -.382
Kurtosis: 2.851
Minimum : -.810
25th % : .730
Median : 1.668
75th % : 2.275
Maximum : 3.357

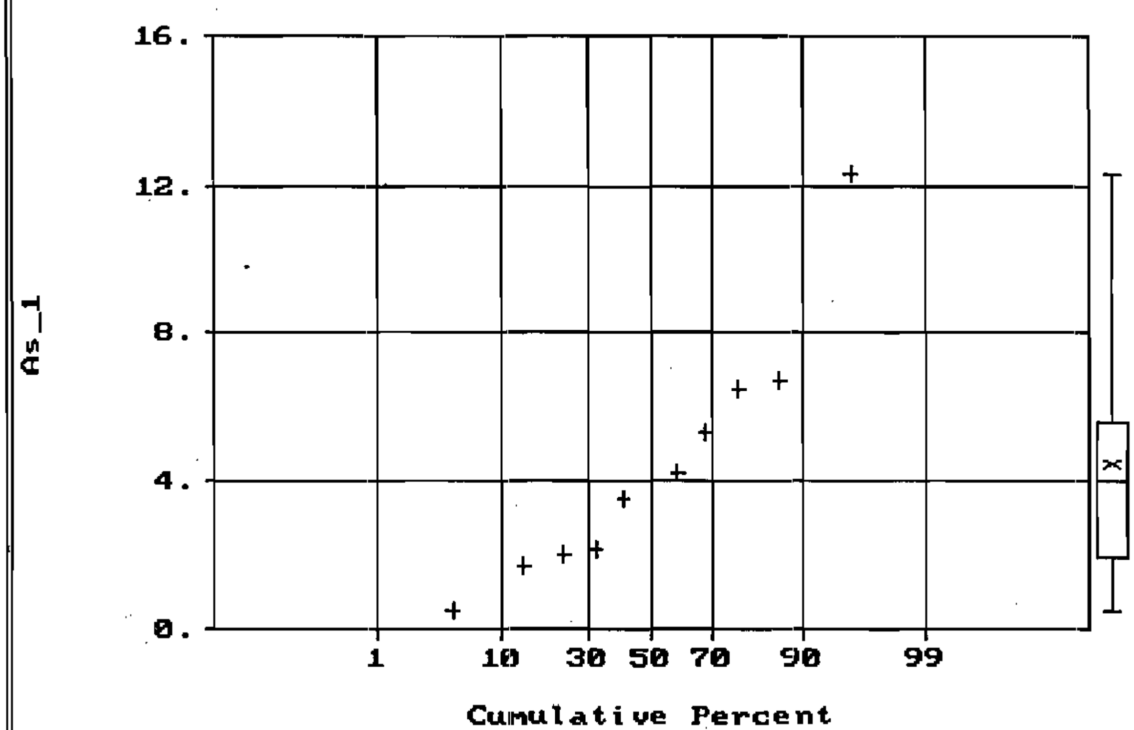
Zone B
AS in surface soil grid samples
4 golf course samples removed
Original values



Statistics

N Total :	11
N Miss :	0
N Used :	11
Mean :	4.432
Variance:	10.786
Std. Dev:	3.284
% C.V. :	74.106
Skewness:	1.175
Kurtosis:	4.019
Minimum :	.450
25th % :	1.925
Median :	4.000
75th % :	5.600
Maximum :	12.300

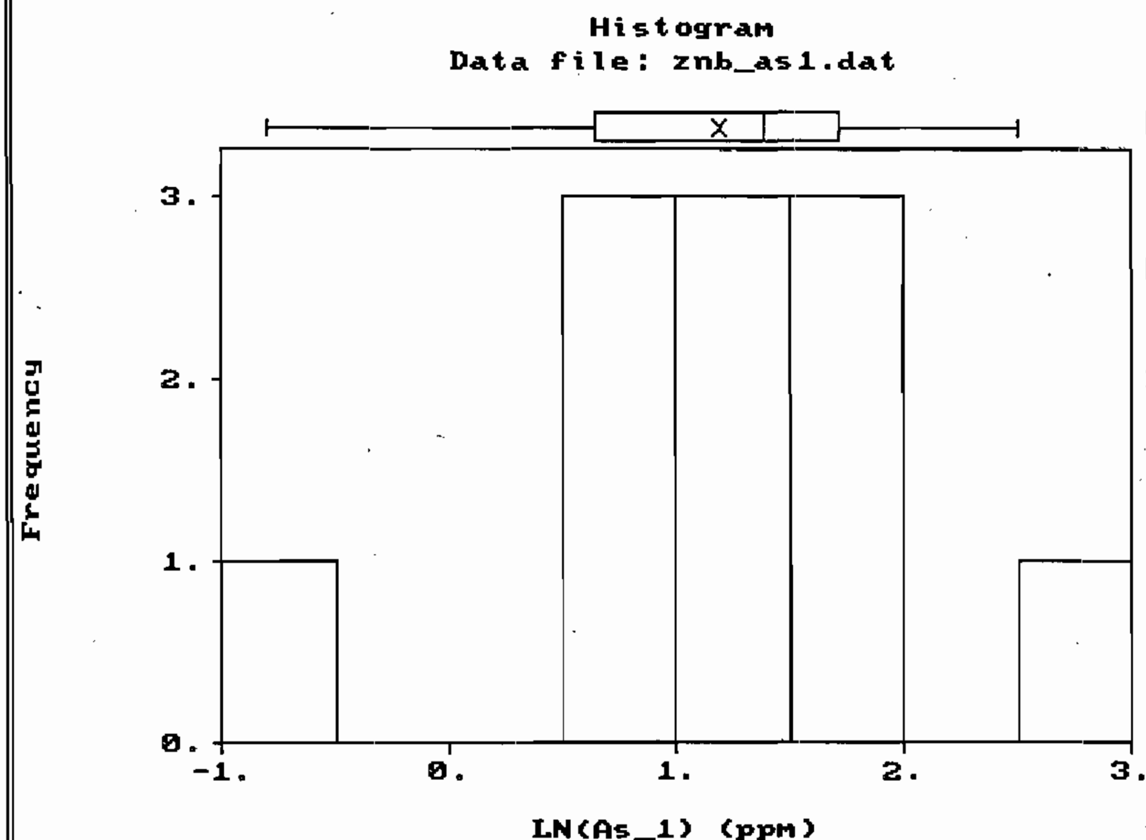
Normal Probability Plot for As_1
Data file: znb_as1.dat



S t a t i s t i c s

N Total :	11
N Miss :	0
N Used :	11
Mean :	4.432
Variance:	10.786
Std. Dev:	3.284
% C.V. :	74.106
Skewness:	1.175
Kurtosis:	4.019
Minimum :	.450
25th % :	1.925
Median :	4.000
75th % :	5.600
Maximum :	12.300

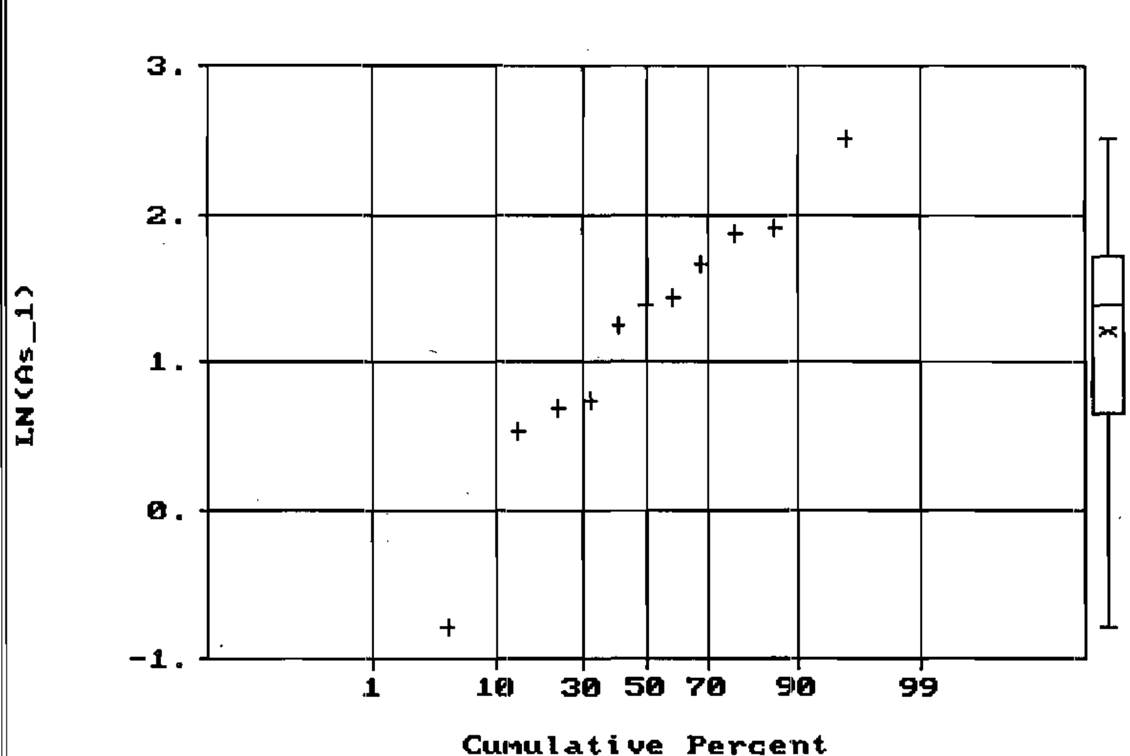
Zone B
AS in surface soil grid samples
4 golf course samples removed
LN - transformed values



Statistics

N Total :	11
N Miss :	0
N Used :	11
Mean :	1.199
Variance:	.788
Std. Dev:	.888
% C.V. :	74.014
Skewness:	-.821
Kurtosis:	3.488
Minimum :	-.799
25th % :	.653
Median :	1.386
75th % :	1.719
Maximum :	2.510

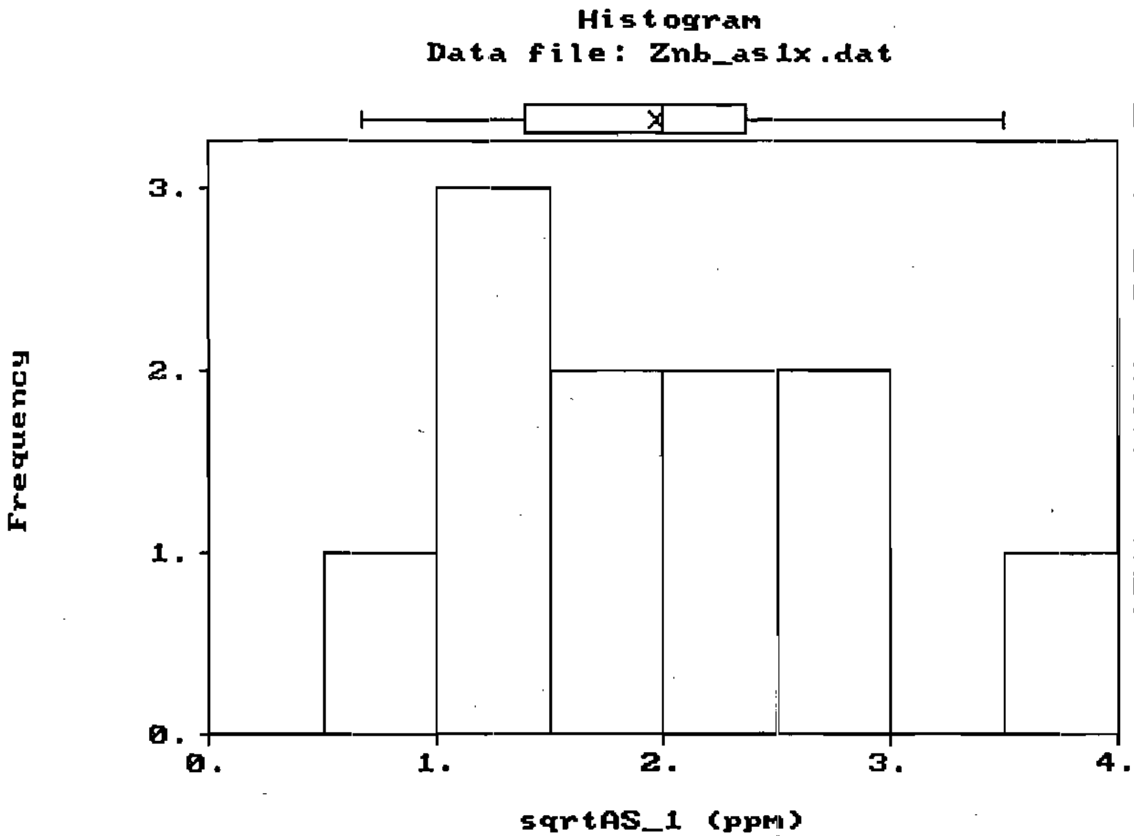
Normal Probability Plot for LN(As_1)
Data file: znb_as1.dat



Statistics

N Total	:	11
N Miss	:	0
N Used	:	11
Mean	:	1.199
Variance	:	.788
Std. Dev	:	.888
% C.V.	:	74.014
Skewness	:	-.821
Kurtosis	:	3.488
Minimum	:	-.799
25th %	:	.653
Median	:	1.386
75th %	:	1.719
Maximum	:	2.510

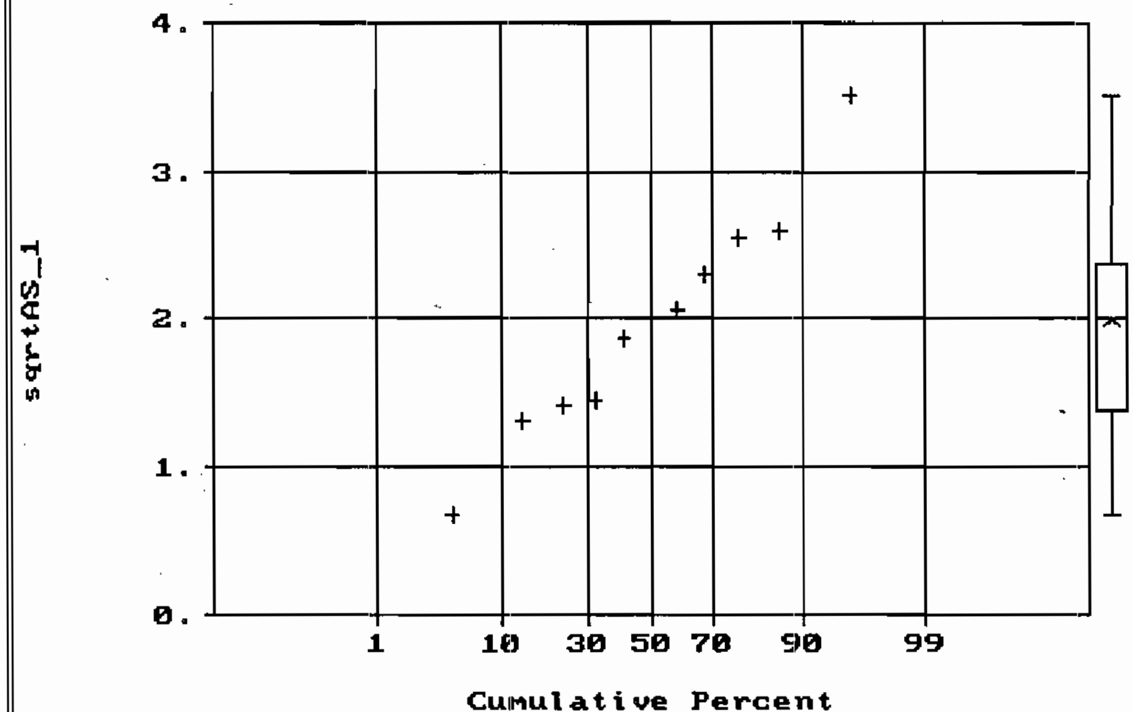
Zone B
AS in surface soil grid samples
4 golf course samples removed
Square-root transformed values



Statistics

N Total :	11
N Miss :	0
N Used :	11
Mean :	1.973
Variance:	.592
Std. Dev:	.769
% C.V. :	38.993
Skewness:	.286
Kurtosis:	2.841
Minimum :	.671
25th % :	1.387
Median :	2.000
75th % :	2.364
Maximum :	3.507

Normal Probability Plot for sqrtAS_1
Data file: Znb_as1x.dat



Statistics

N Total	:	11
N Miss	:	0
N Used	:	11
Mean	:	1.973
Variance	:	.592
Std. Dev	:	.769
% C.V.	:	38.993
Skewness	:	.286
Kurtosis	:	2.841
Minimum	:	.671
25th %	:	1.387
Median	:	2.000
75th %	:	2.364
Maximum	:	3.507

MEMO 1/15/97

FROM: EnSafe
TO: SCDHEC

RE: Background concentrations in Zone B soils

This memo responds to the following two general questions raised by SCDHEC during their review of the Zone B RFI Report:

- Why is the 95% UTL for arsenic in surface soil so much higher than the maximum reported arsenic concentration in soil samples?
- Is the method cited for UTL determination appropriate for soil? (The EPA reference specifies groundwater.)

The 95% UTL calculated for arsenic in surface soil in Zone B is 90.0 mg/kg ~~(risk = 2E-04)~~, which is the highest arsenic surface soil UTL among the six calculated to date (for Zones A, B, C, E, H, and I). It was calculated by the method presented in Section 5 of the report and previously approved by SCDHEC and USEPA, according to the following formula for log-transformed data values:

$$\begin{aligned} UTL &= \exp[X + ks] \\ &= \exp[1.654 + (2.566)(1.109)] \\ &= 89.99 \text{ mg/kg} \end{aligned}$$

The maximum reported arsenic concentration in Zone B surface soil is 28.7 mg/kg ~~(risk = 8E-05)~~ in grid sample GDBSB01101; the maximum for subsurface soil is 33.9 mg/kg in grid sample GDBSB00102. The calculated 95% UTL for arsenic in subsurface soil in Zone B is 48.9 mg/kg.

Site sample concentrations of inorganic chemicals are compared to background for evidence of site contamination. As explained in Section 5 of the report, the UTL approach for determining background levels was adopted in part because it makes allowance for the natural variability of background chemical distributions. The type of highly variable, naturally occurring background concentrations seen in NAVBASE soils would result in unacceptably high false positive rates of contaminant determination if the comparisons were made using the "2 x mean" or similar rule-of-thumb approaches. In answer to the second question shown above, the UTL method is purely a statistically-based answer to the problem of data variability, and should not be limited to a specific environmental medium. The same kinds of random mixing and dilution that yield the observed distribution of chemical concentrations in groundwater apply to soil concentrations. In the past, USEPA has recommended the use of upper tolerance limits for soils in the context of deciding whether a site meets cleanup standards (*Methods for Evaluating the Attainment of Cleanup Standards Volume I: Soils and Solid Media*, EPA 230/02-89-042, 1989). The fact that the tolerance limit method may be discussed in USEPA guidance exclusively in terms of groundwater monitoring is largely a function of publication dates for soil and groundwater guidance vs. evolving ideas about appropriate statistical methods.

A tolerance interval is constructed to contain a designated proportion of the population. If it is designed to contain 95% of all possible samples, the 5% of the samples that can be expected to exceed the UTL represent the false positive rate for uncontaminated sites. To contain the desired 95% of the population ("95% coverage") with 95% confidence, the UTL must be set somewhat higher than would be the case for a lower confidence level. Use of UTLs with 95% coverage and 95% confidence is justified because the UTL test is intended to identify individual "hot spot" samples only; the companion Wilcoxon test is designed to identify entire sites whose sample concentrations significantly exceed background.

Background arsenic concentrations in Zone B surface soil are lognormally distributed, as are most elemental metal concentrations in uncontaminated soils worldwide (Frink, C. R., 1996, A Perspective on Metals in Soils, *Journal of Soil Contamination*, 5(4):329-359). Compared to the normal distribution, the lognormal distribution is generally a better representation of the reality of environmental data values; and use of the lognormal distribution allows analysis of datasets using standard statistical methods. Page 2 of the 1992 Addendum to the *Interim Final Guidance, Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities* contains a discussion of lognormal environmental data, with possible explanations of why lognormal distributions often apply.

One effect of employing the lognormal distribution as a model is to incorporate high-end data values that might otherwise be considered outliers. To include 95% of the lognormally distributed values within the tolerance interval with 95% confidence, the UTL must be set relatively high. For the rather small surface soil datasets in Zone B (both background and site), the highest observed data values (i.e., the largest observed concentrations) can be expected to be considerably lower than the UTL, simply because the highest background surface soil concentrations in the ground were probably not seen in the limited volume of soil that was sampled. Since the UTL is based on a theoretical distribution, it takes these possibly unseen higher concentrations into account. The highest observed arsenic concentration in surface soil at a Zone B site is 5.4 mg/kg (~~risk = 1E-05~~) in sample 507SB00301, which is lower than the maximum background concentration for Zone B (28.7 mg/kg) and lower than the lowest arsenic surface soil UTL for *any* zone (9.4 mg/kg for Zone A), indicating that the relatively high UTL in Zone B should not be of concern because none of the site samples comes close to exceeding it.

The maximum arsenic surface soil concentration (5.4 mg/kg) equates with a human health risk of 1E-05. The maximum arsenic surface soil concentration in background samples (28.7 mg/kg) equates with a risk of 8E-05. The arsenic UTL calculated for Zone B surface soil (90 mg/kg) equates with a risk of 2E-04. USEPA has accepted arsenic-related risk up to 1E-03 due to the low mortality rate of the associated cancer. Consequently, arsenic soil concentrations for AOC 507 and Zone B background would not result in an unacceptable risk.

The method for determining COPCs at NAVBASE sites uses a twofold decision process. One is a direct comparison of maximum site sample concentrations with UTLs and the other is a comparison of site vs. background populations (the Wilcoxon rank sum test). Arsenic concentrations in surface soil at AOC 507 neither exceeded the background UTL individually nor were significantly higher than the background population as a group. Therefore, arsenic was not considered in the formal human health risk assessment for AOC 507.

APPENDIX 3
TOLERANCE FACTORS (K) FOR ONE-SIDED NORMAL TOLERANCE INTERVALS WITH PROBABILITY LEVEL (CONFIDENCE FACTOR) Y = 0.95 AND COVERAGE P = 95%

n	K	n	K
3	7.655	75	1.972
4	5.145	100	1.924
5	4.202	125	1.891
6	3.707	150	1.868
7	3.399	175	1.850
8	3.188	200	1.836
9	3.031	225	1.824
10	2.911	250	1.814
11	2.815	275	1.806
12	2.736	300	1.799
13	2.670	325	1.792
14	2.614	350	1.787
15	2.566	375	1.782
16	2.523	400	1.777
17	2.486	425	1.773
18	2.543	450	1.769
19	2.423	475	1.766
20	2.396	500	1.763
21	2.371	525	1.760
22	2.350	550	1.757
23	2.329	575	1.754
24	2.309	600	1.752
25	2.292	625	1.750
30	2.220	650	1.748
35	2.166	675	1.746
40	2.125	700	1.744
45	2.092	725	1.742
50	2.065	750	1.740
55	2.036	775	1.739
60	2.017	800	1.737
65	2.000	825	0.736

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META												
	SAMPLE ID ------->	GDB-S-B001-01		GDB-C-B001-01		GDB-S-B001-02		GDB-S-B002-01		GDB-S-B002-02		GDB-S-B003-01	
	ORIGINAL ID ----->	GDBSB00101		GDBCB00101		GDBSB00102		GDBSB00201		GDBSB00202		GDBSB00301	
	LAB SAMPLE ID --->	L5540-124		L5530-3		L5540-125		L5540-122		L5540-123		L5540-88	
	ID FROM REPORT -->	GDBSB00101		GDBCB00101		GDBSB00102		GDBSB00201		GDBSB00202		GDBSB00301	
	SAMPLE DATE ----->	10/04/95		10/04/95		10/04/95		10/04/95		10/04/95		10/04/95	
	DATE EXTRACTED -->	10/12/95		10/11/95		10/12/95		10/12/95		10/12/95		10/12/95	
	DATE ANALYZED --->	10/22/95		10/22/95		10/22/95		10/22/95		10/22/95		10/22/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	L5540S	VAL	L5530S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL
7429-90-5	Aluminum (Al)	55500.		40300.		55600.		39500.		32900.		11500.	
7440-36-0	Antimony (Sb)	15.7	U	15.1	U	25.3	U	13.3	U	22.6		12.7	U
7440-38-2	Arsenic (As)	12.3		26.9		33.9		22.1		15.8		9.	
7440-39-3	Barium (Ba)	57.7	J	50.9	J	65.	J	94.7		58.9	J	29.6	J
7440-41-7	Beryllium (Be)	1.7		1.2	J	1.7	J	1.2	J	1.1	J	0.44	J
7440-43-9	Cadmium (Cd)	1.5	U	1.5	U	2.5	U	1.3	U	1.8	U	1.2	U
7440-70-2	Calcium (Ca)	5380.		11400.		24900.		10400.		24100.		11400.	
7440-47-3	Chromium (Cr)	74.3		53.3		75.7		54.8		48.5		20.	
7440-48-4	Cobalt (Co)	11.4	J	7.	J	10.6	J	9.4	J	8.	J	2.	J
7440-50-8	Copper (Cu)	37.5		33.5	J	47.		122.		36.8		14.2	
7439-89-6	Iron (Fe)	48700.		42600.		49100.		38000.		29100.		11500.	
7439-92-1	Lead (Pb)	63.	J	50.2		78.6	J	310.	J	145.	J	79.6	J
7439-95-4	Magnesium (Mg)	6990.		5490.		9070.		4380.		4640.		1480.	
7439-96-5	Manganese (Mn)	420.		579.		744.		454.		288.		178.	
7439-97-6	Mercury (Hg)	0.38		0.39		2.		0.77		0.73		1.3	
7440-02-0	Nickel (Ni)	29.4		23.6		25.		19.8		15.5		10.6	
7440-09-7	Potassium (K)	3570.	J	2500.		4720.	J	2260.	J	2250.	J	791.	J
7782-49-2	Selenium (Se)	1.7		0.9	U	2.1	J	1.9		2.1		0.75	U
7440-22-4	Silver (Ag)	0.93	U	1.	U	1.5	U	0.78	U	1.1	U	1.1	J
7440-23-5	Sodium (Na)	6670.		5490.		12600.		366.	J	934.	J	298.	J
7440-28-0	Thallium (Tl)	1.3	U	1.2	U	2.	U	1.1	U	1.4	U	1.	U
7440-62-2	Vanadium (V)	101.		78.9		102.		71.9		64.5		22.7	
7440-66-6	Zinc (Zn)	148.		132.		199.		266.		238.		88.2	
7440-31-5	Tin (Sn)	11.4	U	14.8	J	20.4	J	9.6	U	13.3	U	9.4	J
57-12-5	Cyanide (Cn)	?????????		?????????		?????????		?????????		?????????		?????????	

(No CN hits in Zone B soil.)

*** Validation Complete ***

DATALCP3
02/14/96

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META													
	SAMPLE ID -------->	GDB-S-B004-01		GDB-S-B004-02		GDB-S-B005-01		GDB-S-B005-02		GDB-S-B006-01		GDB-S-B006-02	
	ORIGINAL ID ------>	GDBSB00401		GDBSB00402		GDBSB00501		GDBSB00502		GDBSB00601		GDBSB00602	
	LAB SAMPLE ID --->	L5540-119		L5540-121		L5540-128		L5540-129		L5540-126		L5540-127	
	ID FROM REPORT -->	GDBSB00401		GDBSB00402		GDBSB00501		GDBSB00502		GDBSB00601		GDBSB00602	
	SAMPLE DATE ----->	10/04/95		10/04/95		10/04/95		10/04/95		10/04/95		10/04/95	
	DATE EXTRACTED -->	10/12/95		10/12/95		10/12/95		10/12/95		10/12/95		10/12/95	
	DATE ANALYZED --->	10/22/95		10/22/95		10/22/95		10/22/95		10/22/95		10/22/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL
7429-90-5	Aluminum (Al)	6320.		3530.		9910.		3790.		10200.		17200.	
7440-36-0	Antimony (Sb)	10.4	U	10.6	U	10.8	U	12.	U	11.2	U	12.1	U
7440-38-2	Arsenic (As)	1.7	J	0.84	U	5.3		0.96	U	4.		3.8	
7440-39-3	Barium (Ba)	32.2	J	20.1	J	56.5		22.2	J	34.9	J	25.2	J
7440-41-7	Beryllium (Be)	0.2	U	0.21	U	0.57	J	0.23	U	0.35	J	0.28	J
7440-43-9	Cadmium (Cd)	1.	U	1.	U	1.1	U	1.2	U	1.1	U	1.2	U
7440-70-2	Calcium (Ca)	792.	J	425.	J	1640.		329.	J	835.	J	691.	J
7440-47-3	Chromium (Cr)	9.		4.4		14.1		4.5		14.6		26.6	
7440-48-4	Cobalt (Co)	1.4	J	1.2	U	5.4	J	1.4	U	2.1	J	2.4	J
7440-50-8	Copper (Cu)	9.4		1.3	J	38.4		2.1	J	21.2		2.9	J
7439-89-6	Iron (Fe)	2630.		2170.		6980.		2300.		6260.		13800.	
7439-92-1	Lead (Pb)	48.3	J	2.2	J	44.9	J	2.4	J	47.8	J	9.8	J
7439-95-4	Magnesium (Mg)	299.	J	288.	J	581.	J	252.	J	429.	J	881.	J
7439-96-5	Manganese (Mn)	62.		20.6		192.		46.1		81.3		22.9	
7439-97-6	Mercury (Hg)	0.1	U	0.11	U	0.11	U	0.12	U	0.11	U	0.12	U
7440-02-0	Nickel (Ni)	3.4	J	2.9	U	11.1		3.3	U	5.1	J	7.3	J
7440-09-7	Potassium (K)	430.	J	108.	UJ	350.	J	216.	J	219.	J	690.	J
7782-49-2	Selenium (Se)	0.62	U	0.63	U	0.78	J	0.72	U	0.66	U	0.72	J
7440-22-4	Silver (Ag)	0.61	U	0.62	U	0.63	U	0.7	U	0.66	U	0.71	U
7440-23-5	Sodium (Na)	179.	J	191.	J	248.	J	207.	J	213.	J	193.	J
7440-28-0	Thallium (Tl)	0.83	U	0.84	U	0.85	U	0.96	U	0.88	U	0.93	U
7440-62-2	Vanadium (V)	8.6	J	4.2	J	17.		4.9	J	17.6		32.2	
7440-66-6	Zinc (Zn)	64.2		7.2		194.		6.		86.4		19.2	
7440-31-5	Tin (Sn)	8.2	J	7.7	U	13.7	J	8.7	U	8.1	U	8.8	U
57-12-5	Cyanide (Cn)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META		GDB-S-B007-01		GDB-S-B007-02		GDB-S-B008-01		GDB-C-B008-01		GDB-S-B008-02		GDB-S-B009-01	
	SAMPLE ID ------->	GDB-S-B007-01		GDB-S-B007-02		GDB-S-B008-01		GDB-C-B008-01		GDB-S-B008-02		GDB-S-B009-01	
	ORIGINAL ID ----->	GDBSB00701		GDBSB00702		GDBSB00801		GDBCB00801		GDBSB00802		GDBSB00901	
	LAB SAMPLE ID --->	L5540-103		L5540-104		L5540-101		L5530-1		L5540-102		L5540-105	
	ID FROM REPORT -->	GDBSB00701		GDBSB00702		GDBSB00801		GDBCB00801		GDBSB00802		GDBSB00901	
	SAMPLE DATE ----->	10/04/95		10/04/95		10/04/95		10/04/95		10/04/95		10/04/95	
	DATE EXTRACTED -->	10/12/95		10/12/95		10/12/95		10/11/95		10/12/95		10/12/95	
	DATE ANALYZED --->	10/22/95		10/22/95		10/22/95		10/22/95		10/22/95		10/22/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5530S	VAL	L5540S	VAL	L5540S	VAL
7429-90-5	Aluminum (Al)	12100.		10100.		8250.		8520.		1970.		7250.	
7440-36-0	Antimony (Sb)	12.	U	12.2	U	10.7	U	10.8	U	10.6	U	11.1	U
7440-38-2	Arsenic (As)	6.5		3.4		2.	J	2.	J	0.83	U	4.2	
7440-39-3	Barium (Ba)	76.		38.1	J	40.4	J	41.6	J	13.2	J	29.4	J
7440-41-7	Beryllium (Be)	0.71	J	0.29	J	0.43	J	0.45	J	0.21	U	0.28	J
7440-43-9	Cadmium (Cd)	1.2	U	1.2	U	1.	U	1.1	U	1.	U	1.1	U
7440-70-2	Calcium (Ca)	1580.		580.	J	2020.		1380.		331.	J	3400.	
7440-47-3	Chromium (Cr)	14.		10.4		6.		5.9		2.6		11.	
7440-48-4	Cobalt (Co)	2.1	J	3.	J	1.3	U	1.3	U	1.2	U	1.3	U
7440-50-8	Copper (Cu)	89.2		2.4	J	5.8		5.9	J	1.1	J	10.1	
7439-89-6	Iron (Fe)	5230.		7520.		2910.		3220.		1470.		3460.	
7439-92-1	Lead (Pb)	93.8	J	5.5	J	13.5	J	12.7		1.4	J	58.	J
7439-95-4	Magnesium (Mg)	526.	J	573.	J	341.	J	345.	J	147.	J	342.	J
7439-96-5	Manganese (Mn)	287.		135.		298.		306.		45.7		157.	
7439-97-6	Mercury (Hg)	0.15		0.12	U	0.11	U	0.11	U	0.11	U	0.12	
7440-02-0	Nickel (Ni)	7.9	J	7.1	J	7.2	J	5.8	J	2.9	U	7.6	J
7440-09-7	Potassium (K)	249.	J	176.	J	109.	UJ	110.	U	108.	UJ	145.	J
7782-49-2	Selenium (Se)	0.71	U	0.71	U	0.62	U	0.64	U	0.63	U	0.65	U
7440-22-4	Silver (Ag)	1.6	J	1.5	J	0.63	U	0.84	U	1.2	J	0.81	J
7440-23-5	Sodium (Na)	199.	J	183.	J	165.	J	180.	J	159.	J	201.	J
7440-28-0	Thallium (Tl)	0.94	U	0.95	U	0.83	U	0.86	U	0.83	U	0.87	U
7440-62-2	Vanadium (V)	10.3	J	12.2	J	6.6	J	7.7	J	0.83	UJ	6.5	J
7440-66-6	Zinc (Zn)	105.		14.		19.3		21.4		4.5		30.1	
7440-31-5	Tin (Sn)	8.7	U	8.9	U	10.6	J	7.9	U	7.7	U	8.1	U
57-12-5	Cyanide (Cn)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

DATALCP3
02/14/96

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META													
	SAMPLE ID ------->	GDB-S-B009-02		GDB-S-B010-01		GDB-S-B010-02		GDB-S-B011-01		GDB-S-B011-02		GDB-S-B012-01	
	ORIGINAL ID ----->	GDBSB00902		GDBSB01001		GDBSB01002		GDBSB01101		GDBSB01102		GDBSB01201	
	LAB SAMPLE ID --->	L5540-106		L5540-130		L5540-131		L5540-99		L5540-100		L5540-97	
	ID FROM REPORT -->	GDBSB00902		GDBSB01001		GDBSB01002		GDBSB01101		GDBSB01102		GDBSB01201	
	SAMPLE DATE ----->	10/04/95		10/04/95		10/04/95		10/04/95		10/04/95		10/04/95	
	DATE EXTRACTED -->	10/12/95		10/12/95		10/12/95		10/12/95		10/12/95		10/12/95	
	DATE ANALYZED --->	10/22/95		10/22/95		10/22/95		10/22/95		10/22/95		10/22/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL
7429-90-5	Aluminum (Al)	4930.		8350.		9640.		24000.		6630.		7550.	
[illegible]40-36-0	Antimony (Sb)	11.2	U	12.1	U	14.6	U	15.3	U	13.9	U	11.1	U
7440-38-2	Arsenic (As)	1.2	J	6.7		4.7		28.7		11.7		2.1	J
7440-39-3	Barium (Ba)	23.1	J	56.7		19.7	J	46.7	J	14.8	J	14.9	J
7440-41-7	Beryllium (Be)	0.22	U	0.34	J	0.29	U	0.88	J	0.39	J	0.22	U
7440-43-9	Cadmium (Cd)	1.1	U	1.2	U	1.4	U	1.5	U	1.4	U	1.1	U
7440-70-2	Calcium (Ca)	589.	J	115000.		182000.		7470.		982.	J	406.	J
7440-47-3	Chromium (Cr)	4.4		35.7		48.1		38.9		11.4		6.6	
7440-48-4	Cobalt (Co)	1.3	U	3.2	J	1.9	J	5.3	J	1.6	U	1.3	U
7440-50-8	Copper (Cu)	1.7	J	18.3		14.1		28.2		1.1	J	3.8	J
7439-89-6	Iron (Fe)	3380.		6110.		6470.		28300.		26000.		2760.	
7439-92-1	Lead (Pb)	3.2	J	76.1	J	9.	J	75.	J	4.1	J	12.9	J
7439-95-4	Magnesium (Mg)	319.	J	3640.		6120.		3680.		1500.		226.	J
7439-96-5	Manganese (Mn)	31.2		39.3		37.5		371.		53.8		27.2	
7439-97-6	Mercury (Hg)	0.11	U	0.12	U	0.15	U	1.5		0.14	U	0.11	U
7440-02-0	Nickel (Ni)	3.1	U	18.8		20.6		16.4		6.5	J	4.7	J
7440-09-7	Potassium (K)	114.	UJ	1010.	J	970.	J	1540.	J	609.	J	113.	UJ
7782-49-2	Selenium (Se)	0.65	U	2.8		3.8		0.9	U	0.81	U	0.66	U
7440-22-4	Silver (Ag)	1.7	J	0.71	U	0.86	U	1.7	J	1.3	J	0.65	U
7440-23-5	Sodium (Na)	170.	J	574.	J	844.	J	837.	J	1600.		174.	J
[illegible]40-28-0	Thallium (Tl)	0.87	U	0.94	U	1.2	U	1.2	U	1.1	U	0.88	U
[illegible]440-62-2	Vanadium (V)	3.3	J	24.5		28.3		51.6		16.2		6.6	J
7440-66-6	Zinc (Zn)	7.6		61.7		70.2		178.		8.8		18.2	
7440-31-5	Tin (Sn)	8.1	U	8.8	U	10.6	U	12.5	J	10.1	U	8.1	U
57-12-5	Cyanide (Cn)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META													
	SAMPLE ID ------->	GDB-S-B012-02		GDB-S-B013-01		GDB-S-B013-02		GDB-S-B014-01		GDB-S-B014-02		GDB-S-B015-01	
	ORIGINAL ID ------>	GDBSB01202		GDBSB01301		GDBSB01302		GDBSB01401		GDBSB01402		GDBSB01501	
	LAB SAMPLE ID --->	L5540-98		L5540-95		L5540-96		L5540-91		L5540-94		L5540-117	
	ID FROM REPORT -->	GDBSB01202		GDBSB01301		GDBSB01302		GDBSB01401		GDBSB01402		GDBSB01501	
	SAMPLE DATE ----->	10/04/95		10/04/95		10/04/95		10/04/95		10/04/95		10/04/95	
	DATE EXTRACTED -->	10/12/95		10/12/95		10/12/95		10/12/95		10/12/95		10/12/95	
	DATE ANALYZED --->	10/22/95		10/22/95		10/22/95		10/22/95		10/22/95		10/22/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL	L5540S	VAL
7429-90-5	Aluminum (Al)	11200.		13100.		14900.		11200.		2130.		10700.	
7440-36-0	Antimony (Sb)	11.1	U	12.1	U	13.5	U	10.9	U	12.1	U	12.8	J
7440-38-2	Arsenic (As)	1.7	J	12.3		10.8		3.5		1.7	J	0.89	U
7440-39-3	Barium (Ba)	47.3		36.2	J	23.1	J	59.		11.5	J	44.2	
7440-41-7	Beryllium (Be)	0.48	J	0.46	J	0.55	J	0.59	J	0.24	U	0.31	J
7440-43-9	Cadmium (Cd)	1.1	U	1.2	U	1.3	U	1.1	U	1.2	U	1.1	U
7440-70-2	Calcium (Ca)	559.	J	31500.		7340.		614.	J	279.	J	59900.	
7440-47-3	Chromium (Cr)	5.9		29.3		23.7		10.1		2.5		22.1	
7440-48-4	Cobalt (Co)	1.3	U	2.7	J	2.7	J	1.7	J	1.4	U	2.7	J
7440-50-8	Copper (Cu)	1.8	J	23.3		15.8		10.2		0.8	J	29.6	
7439-89-6	Iron (Fe)	3380.		11700.		15100.		5290.		1650.		10400.	
7439-92-1	Lead (Pb)	3.4	J	50.9	J	24.4	J	43.7	J	2.6	J	25.7	J
7439-95-4	Magnesium (Mg)	407.	J	2020.		1620.		538.	J	178.	J	1030.	J
7439-96-5	Manganese (Mn)	99.2		162.		152.		243.		8.6		224.	
7439-97-6	Mercury (Hg)	0.11	U	0.25		0.18		0.11	U	0.12	U	0.27	
7440-02-0	Nickel (Ni)	7.5	J	14.		13.7		8.	J	4.6	J	10.9	
7440-09-7	Potassium (K)	114.	UJ	562.	J	471.	J	218.	J	123.	UJ	481.	J
7782-49-2	Selenium (Se)	0.67	U	0.69	U	0.81	U	0.66	U	0.72	U	1.6	
7440-22-4	Silver (Ag)	1.4	J	1.7	J	1.8	J	0.72	J	1.3	J	0.66	U
7440-23-5	Sodium (Na)	166.	J	428.	J	290.	J	193.	J	185.	J	638.	J
7440-28-0	Thallium (Tl)	0.89	U	0.93	U	1.1	U	0.88	U	0.96	U	0.89	U
7440-62-2	Vanadium (V)	4.6	J	25.6		31.4		10.1	J	0.95	UJ	15.8	
7440-66-6	Zinc (Zn)	8.1		135.		66.4		30.5		3.7	J	166.	
7440-31-5	Tin (Sn)	8.2	J	10.1	J	9.8	U	7.9	U	8.8	U	8.1	U
57-12-5	Cyanide (Cn)	??????????		??????????		?????????		?????????		?????????		?????????	

*** Validation Complete ***

CHARLESTON - ZONE B
Background Levels in Soil Grid Samples
Metals and CN -- All Values

SW846-META								
	SAMPLE ID ------->	GDB-S-B015-02						
	ORIGINAL ID ----->	GDBSB01502						
	LAB SAMPLE ID --->	L5540-118						
	ID FROM REPORT -->	GDBSB01502						
	SAMPLE DATE ----->	10/04/95						
	DATE EXTRACTED -->	10/12/95						
	DATE ANALYZED --->	10/22/95						
	MATRIX ---------->	Soil						
	UNITS ----------->	MG/KG	A					
CAS #	Parameter	L5540S	VAL					
7429-90-5	Aluminum (Al)	2730.						
7440-36-0	Antimony (Sb)	11.8	U					
7440-38-2	Arsenic (As)	0.92	U					
7440-39-3	Barium (Ba)	15.5	J					
7440-41-7	Beryllium (Be)	0.23	U					
7440-43-9	Cadmium (Cd)	1.2	U					
7440-70-2	Calcium (Ca)	499.	J					
7440-47-3	Chromium (Cr)	4.8						
7440-48-4	Cobalt (Co)	1.4	U					
7440-50-8	Copper (Cu)	2.5	J					
7439-89-6	Iron (Fe)	1900.						
7439-92-1	Lead (Pb)	2.4	J					
7439-95-4	Magnesium (Mg)	212.	J					
7439-96-5	Manganese (Mn)	128.						
7439-97-6	Mercury (Hg)	0.12	U					
7440-02-0	Nickel (Ni)	3.2	U					
7440-09-7	Potassium (K)	254.	J					
7782-49-2	Selenium (Se)	0.69	U					
7440-22-4	Silver (Ag)	0.69	U					
7440-23-5	Sodium (Na)	193.	J					
7440-28-0	Thallium (Tl)	0.92	U					
7440-62-2	Vanadium (V)	3.9	J					
7440-66-6	Zinc (Zn)	8.						
7440-31-5	Tin (Sn)	8.5	U					
57-12-5	Cyanide (Cn)	??????????						

*** Validation Complete ***

United States
Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
Washington, DC 20460

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EPA/540/R-96/018
PB96-963505
April 1996

Superfund

EPA

Soil Screening Guidance: User's Guide

mercury, there is no significant vapor pressure and H′ may be assumed to be zero.

The use of the soil/water partition equation to calculate SSLs assumes an infinite source of contaminants extending to the top of the aquifer. More detailed models may be used to calculate higher SSLs that are still protective in some situations. For example, contaminants at sites with shallow sources, thick unsaturated zones, degradable contaminants, or unsaturated zone characteristics (e.g., clay layers) may attenuate before they reach ground water. The TBD provides information on the use of unsaturated zone models for soil screening. The decision to use such models should be based on balancing the additional investigative and modeling costs required to apply the more complex models against the cost savings that will result from higher SSLs.

Leach Test. A leach test may be used instead of the soil/water partition equation. In some instances, a leach test may be more useful than the partitioning method, depending on the constituents of concern and the possible presence of RCRA wastes. If this option is chosen, soil parameters are not needed for this pathway. However, a dilution factor must still be calculated. This guidance suggests using the EPA Synthetic Precipitation Leaching Procedure (SPLP, EPA SW-846 Method 1312, U.S. EPA, 1994d). The SPLP was developed to model an acid rain leaching environment and is generally appropriate for a contaminated soil scenario. Like most leach tests, the SPLP may not be appropriate for all situations (e.g., soils contaminated with oily constituents may not yield suitable results). Therefore, apply the SPLP with discretion.

EPA is aware that many leach tests are available for application at hazardous waste sites, some of which may be appropriate in specific situations (e.g., the Toxicity Characteristic Leaching Procedure (TCLP) models leaching in a municipal landfill environment). It is beyond the scope of this document to discuss in detail leaching procedures and the appropriateness of their use.

Stabilization/Solidification of CERCLA and RCRA Wastes (U.S. EPA, 1989b) and the EPA SAB's review of leaching tests (U.S. EPA, 1991b) discuss the application of various leach tests to various waste disposal scenarios. Consult these documents for further information.

See Step 3 for guidance on collecting subsurface soil samples that can be used for leach tests. To ensure adequate precision of leach test results, leach tests should be conducted in triplicate.

Dilution Factor Model. As soil leachate moves through soil and ground water, contaminant concentrations are attenuated by adsorption and degradation. In the aquifer, dilution by clean ground water further reduces concentrations before contaminants reach receptor points (i.e., drinking water wells). This reduction in concentration can be expressed by a dilution attenuation factor (DAF), defined as the ratio of soil leachate concentration to receptor point concentration. The lowest possible DAF is 1, corresponding to the situation where there is no dilution or attenuation of a contaminant (i.e., when the concentration in the receptor well is equal to the soil leachate concentration). On the other hand, high DAF values correspond to a large reduction in contaminant concentration from the contaminated soil to the receptor well.

The Soil Screening Guidance addresses only one of these dilution-attenuation processes: contaminant dilution in ground water. A simple mixing zone equation derived from a water-balance relationship (Equation 11) is used to calculate a site-specific dilution factor. Mixing-zone depth is estimated from Equation 12, which relates it to aquifer thickness along with the other parameters from Equation 11. Mixing zone depth should not exceed aquifer thickness (i.e., use aquifer thickness as the upper limit for mixing zone depth).

Because of the uncertainty resulting from the wide variability in subsurface conditions that affect contaminant migration in ground water, defaults are not provided for the dilution model equations. Instead, a default DAF of 20 has been selected as protective for contaminated soil sources up to 0.5 acre in size. Analyses using the mass-limit models described below suggest that a DAF of 20 may be protective of larger sources as well; however, this hypothesis should be evaluated on a site-specific basis. A discussion of the basis for the default DAF and a description of the mass-limit analysis is found in the TBD. However, since migration to ground

Table A-1 (continued)

Inorganics				Migration to ground water	
CAS No.	Compound	Ingestion (mg/kg)	Inhalation fugitive particulate (mg/kg)	20 DAF (mg/kg)	1 DAF (mg/kg)
7440-36-0	Antimony	31 [b]	— [c]	5	0.3
7440-38-2	Arsenic	0.4 [e]	750 [e]	29 [i]	1 [i]
7440-39-3	Barium	5,500 [b]	6.9E+05 [b]	1,600 [i]	82 [i]
7440-41-7	Beryllium	0.1 [e]	1,300 [e]	63 [i]	3 [i]
7440-43-9	Cadmium	78 [b,m]	1,800 [e]	8 [i]	0.4 [i]
7440-47-3	Chromium (total)	390 [b]	270 [e]	38 [i]	2 [i]
16065-83-1	Chromium (III)	78,000 [b]	— [c]	— [g]	— [g]
18540-29-9	Chromium (VI)	390 [b]	270 [e]	38 [i]	2 [i]
57-12-5	Cyanide (amenable)	1,600 [b]	— [c]	40	2
7439-92-1	Lead	400 [k]	— [k]	— [k]	— [k]
7440-02-0	Nickel	1,600 [b]	13,000 [e]	130 [i]	7 [i]
7782-49-2	Selenium	390 [b]	— [c]	5 [i]	0.3 [i]
7440-22-4	Silver	390 [b]	— [c]	34 [b,i]	2 [b,i]
7440-28-0	Thallium	— [c]	— [c]	0.7 [i]	0.04 [i]
7440-62-2	Vanadium	550 [b]	— [c]	6,000 [b]	300 [b]
7440-66-6	Zinc	23,000 [b]	— [c]	12,000 [b,i]	620 [b,i]

DAF = Dilution and attenuation factor.

[a] Screening levels based on human health criteria only.

[b] Calculated values correspond to a noncancer hazard quotient of 1.

[c] No toxicity criteria available for that route of exposure.

[d] Soil saturation concentration (C_{sat}).

[e] Calculated values correspond to a cancer risk level of 1 in 1,000,000.

[f] Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).

[g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration.

[h] A preliminary remediation goal of 1 mg/kg has been set for PCBs based on *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (U.S. EPA, 1990) and on EPA efforts to manage PCB contamination.

[i] SSL for pH of 6.8.

[j] Ingestion SSL adjusted by a factor of 0.5 to account for dermal exposure.

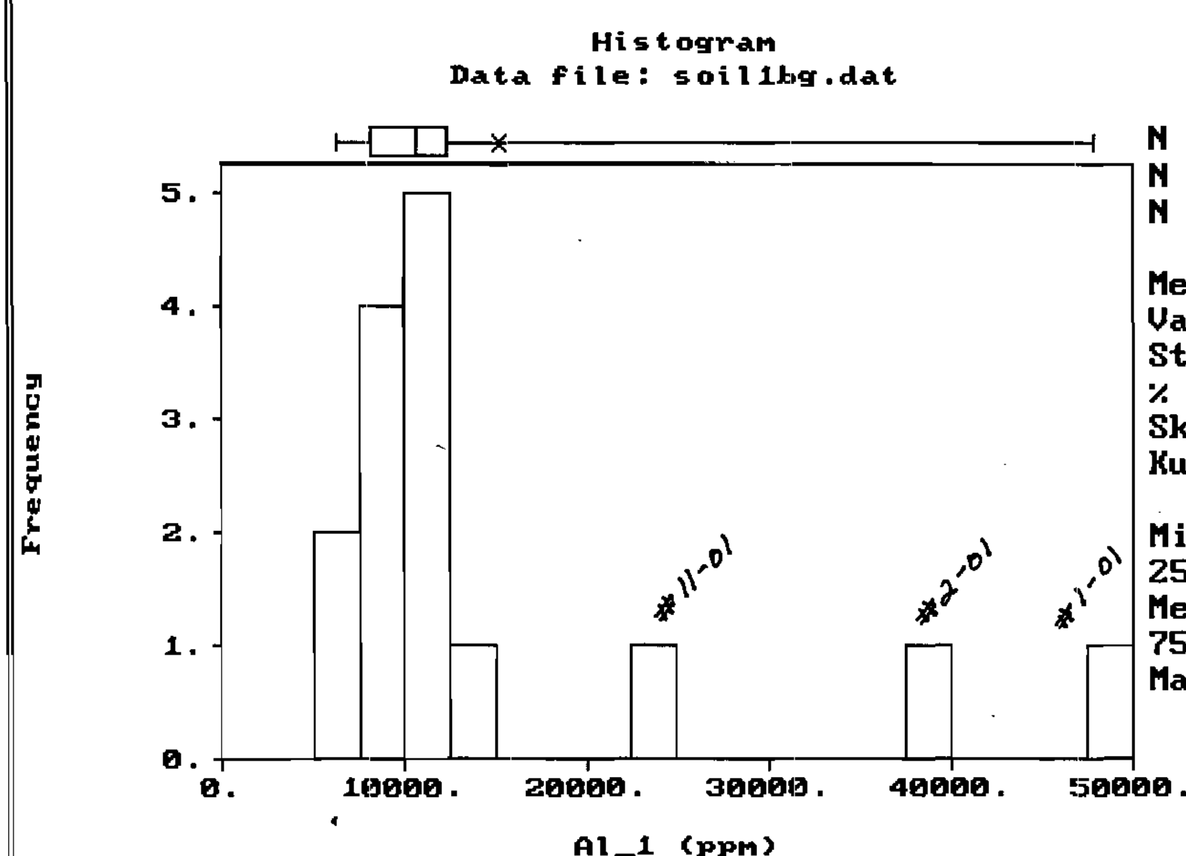
[k] A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA, 1994).

l SSL is based on RfD for mercuric chloride (CAS No. 007487-94-7).

m SSL is based on dietary RfD.

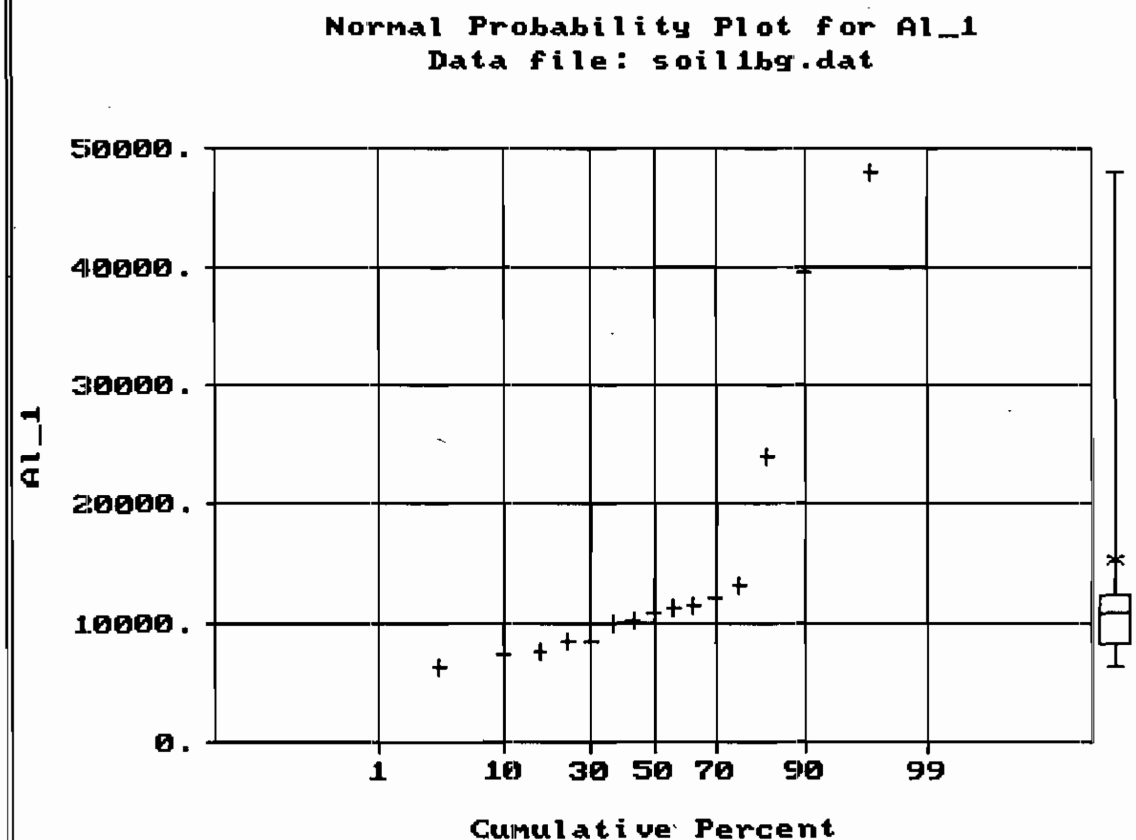
from 1996 EPA Soil Screening Guidance: Technical Background Document

Zone B
Aluminum in surface soil
Original dataset (N=15)



Statistics

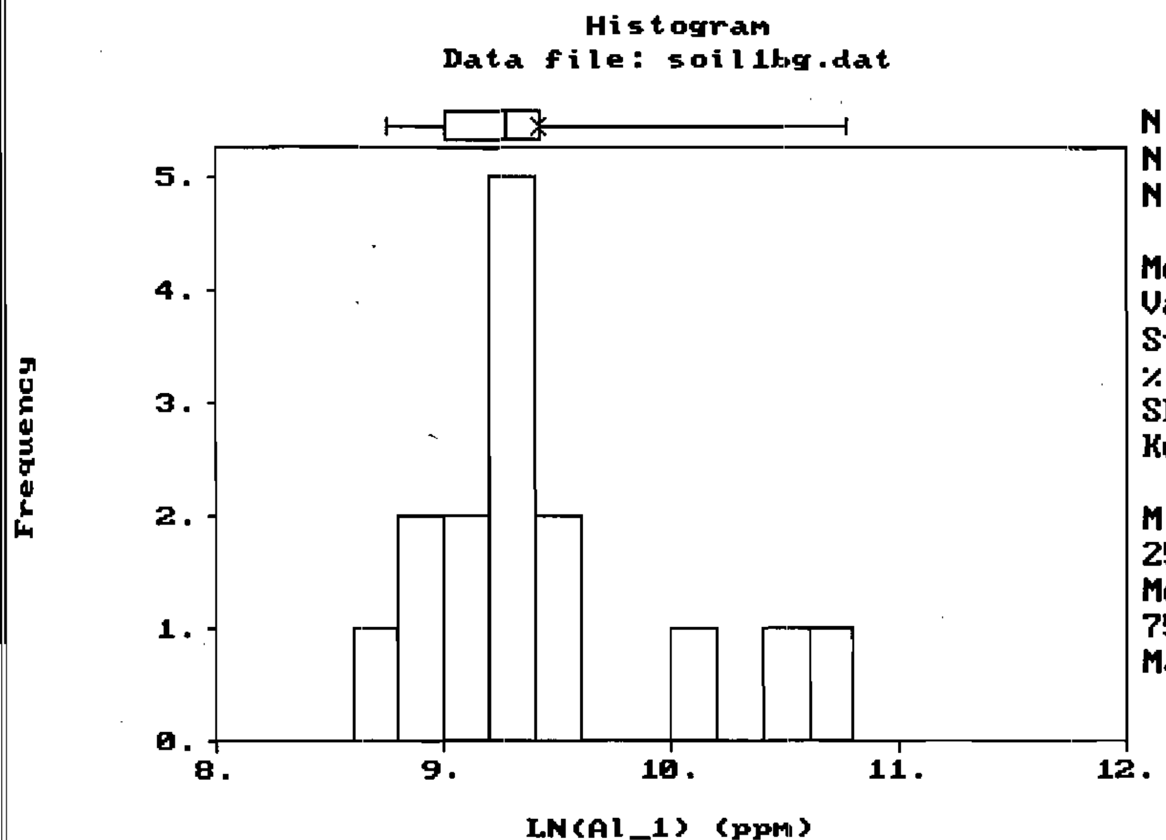
N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	15197.670
Variance	:	153436400.000
Std. Dev	:	12386.950
% C.V.	:	81.506
Skewness	:	1.836
Kurtosis	:	4.937
Minimum	:	6320.000
25th %	:	8150.000
Median	:	10700.000
75th %	:	12350.000
Maximum	:	47900.000



S t a t i s t i c s

N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	15197.670
Variance	:	153436400.000
Std. Dev	:	12386.950
% C.V.	:	81.506
Skewness	:	1.836
Kurtosis	:	4.937
Minimum	:	6320.000
25th %	:	8150.000
Median	:	10700.000
75th %	:	12350.000
Maximum	:	47900.000

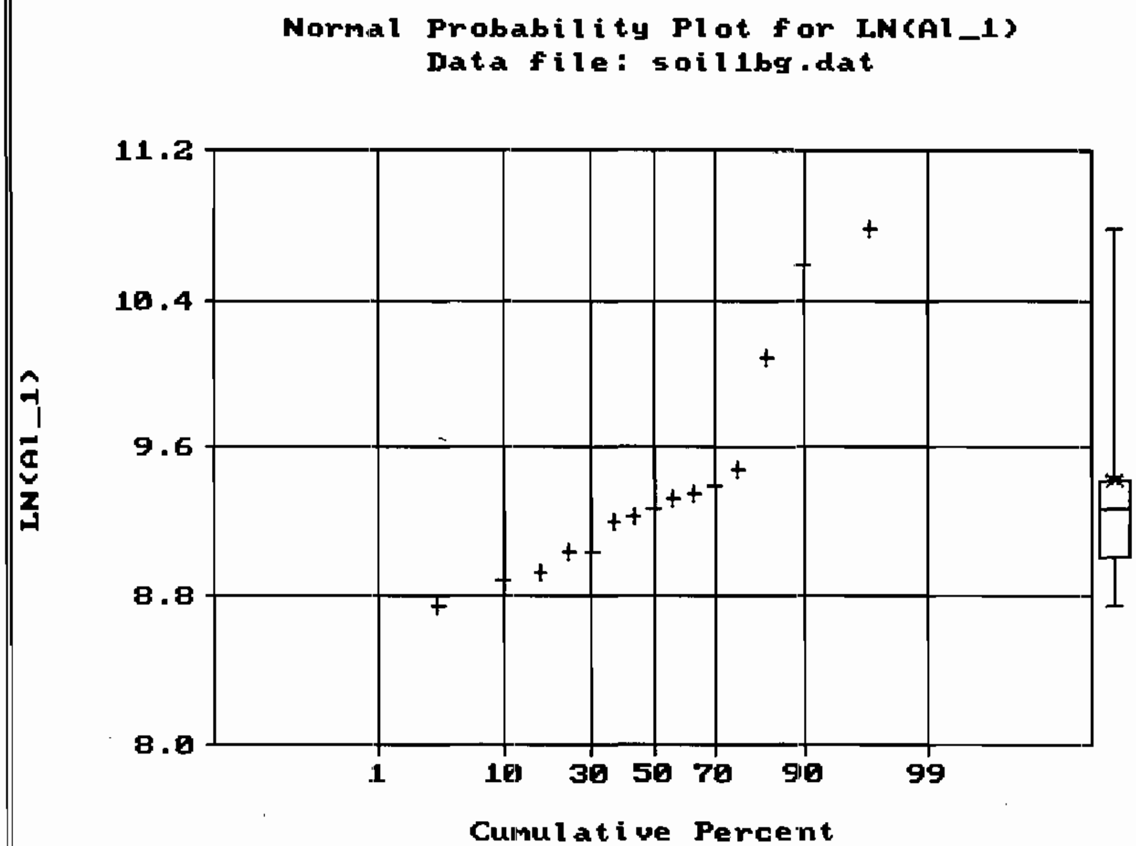
Zone B
AL in surface soil
LN-transformed data



S t a t i s t i c s

N Total :	15
N Miss :	0
N Used :	15
Mean :	9.423
Variance:	.359
Std. Dev:	.600
% C.V. :	6.363
Skewness:	1.242
Kurtosis:	3.415
Minimum :	8.751
25th % :	9.005
Median :	9.278
75th % :	9.421
Maximum :	10.777

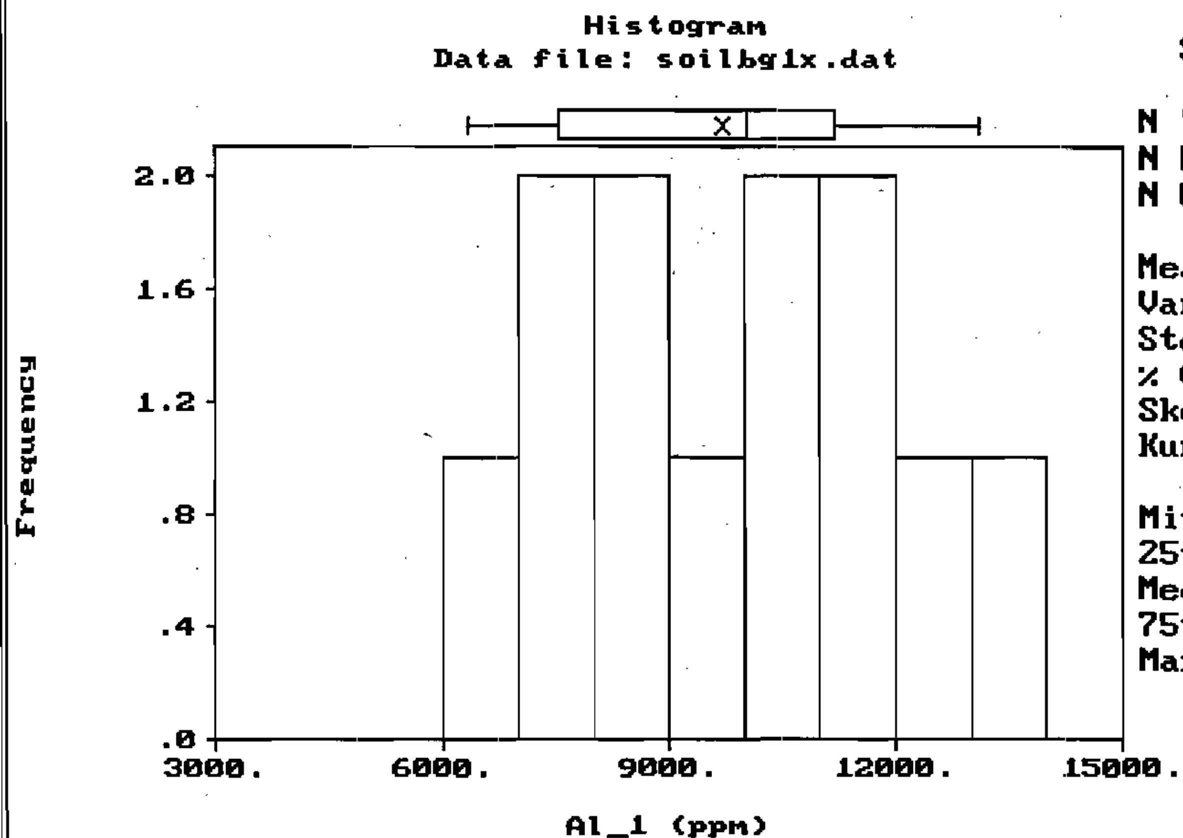
2b



Statistics

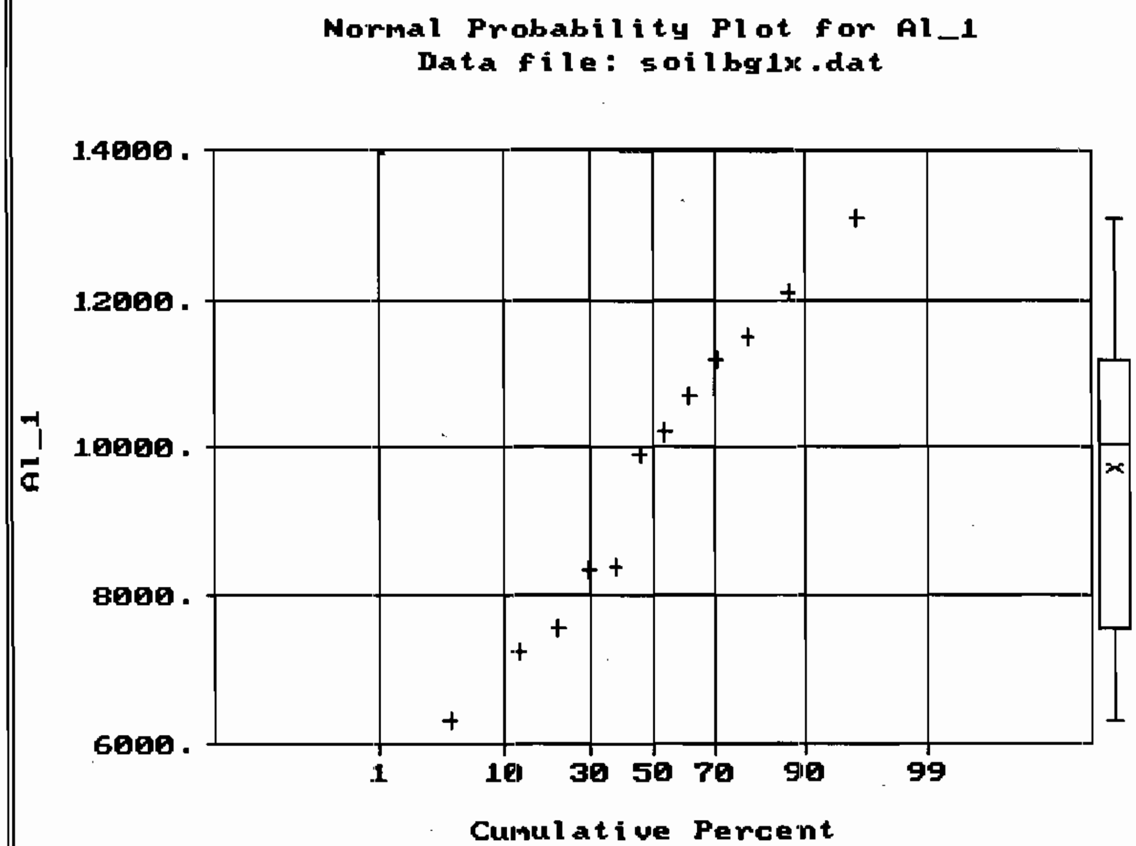
N Total :	15
N Miss :	0
N Used :	15
Mean :	9.423
Variance:	.359
Std. Dev:	.600
% C.V. :	6.363
Skewness:	1.242
Kurtosis:	3.415
Minimum :	8.751
25th % :	9.005
Median :	9.278
75th % :	9.421
Maximum :	10.777

Zone B
AL in surface soil
3 outliers removed (N=12)



Statistics

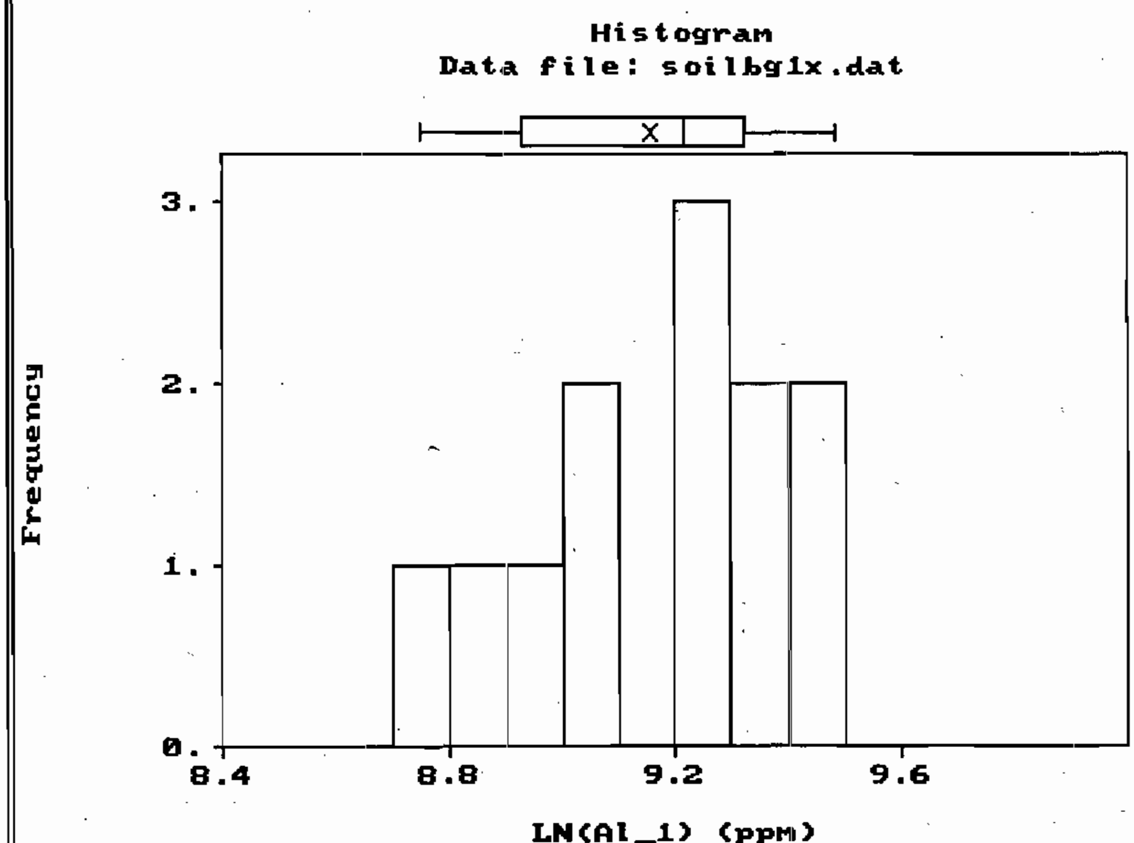
N Total :	15
N Miss :	3
N Used :	12
Mean :	9713.750
Variance:	4518451.000
Std. Dev:	2125.665
% C.V. :	21.883
Skewness:	-.065
Kurtosis:	1.836
Minimum :	6320.000
25th % :	7550.000
Median :	10055.000
75th % :	11200.000
Maximum :	13100.000



S t a t i s t i c s

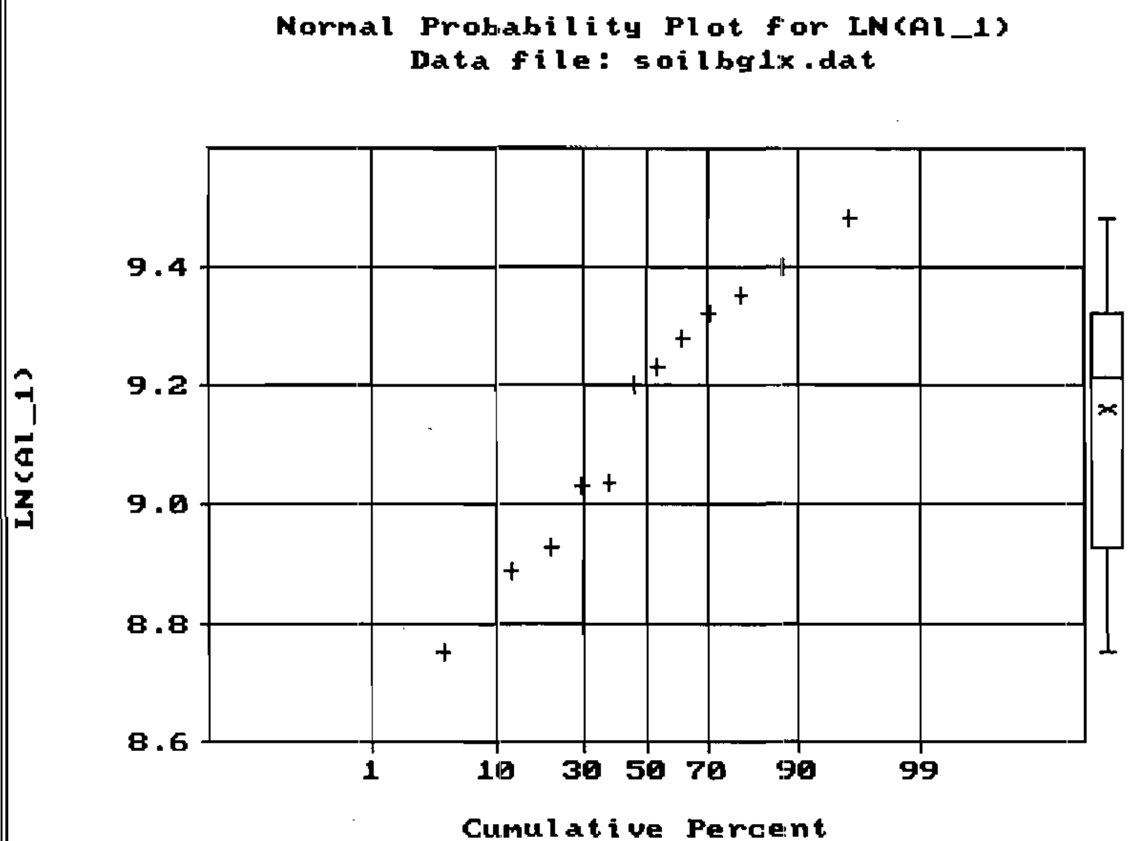
N Total	:	15
N Miss	:	3
N Used	:	12
Mean	:	9713.750
Variance	:	4518451.000
Std. Dev	:	2125.665
% C.V.	:	21.883
Skewness	:	-.065
Kurtosis	:	1.836
Minimum	:	6320.000
25th %	:	7550.000
Median	:	10055.000
75th %	:	11200.000
Maximum	:	13100.000

Zone B
AL in surface soil
3 outliers removed
LN-transformed



Statistics

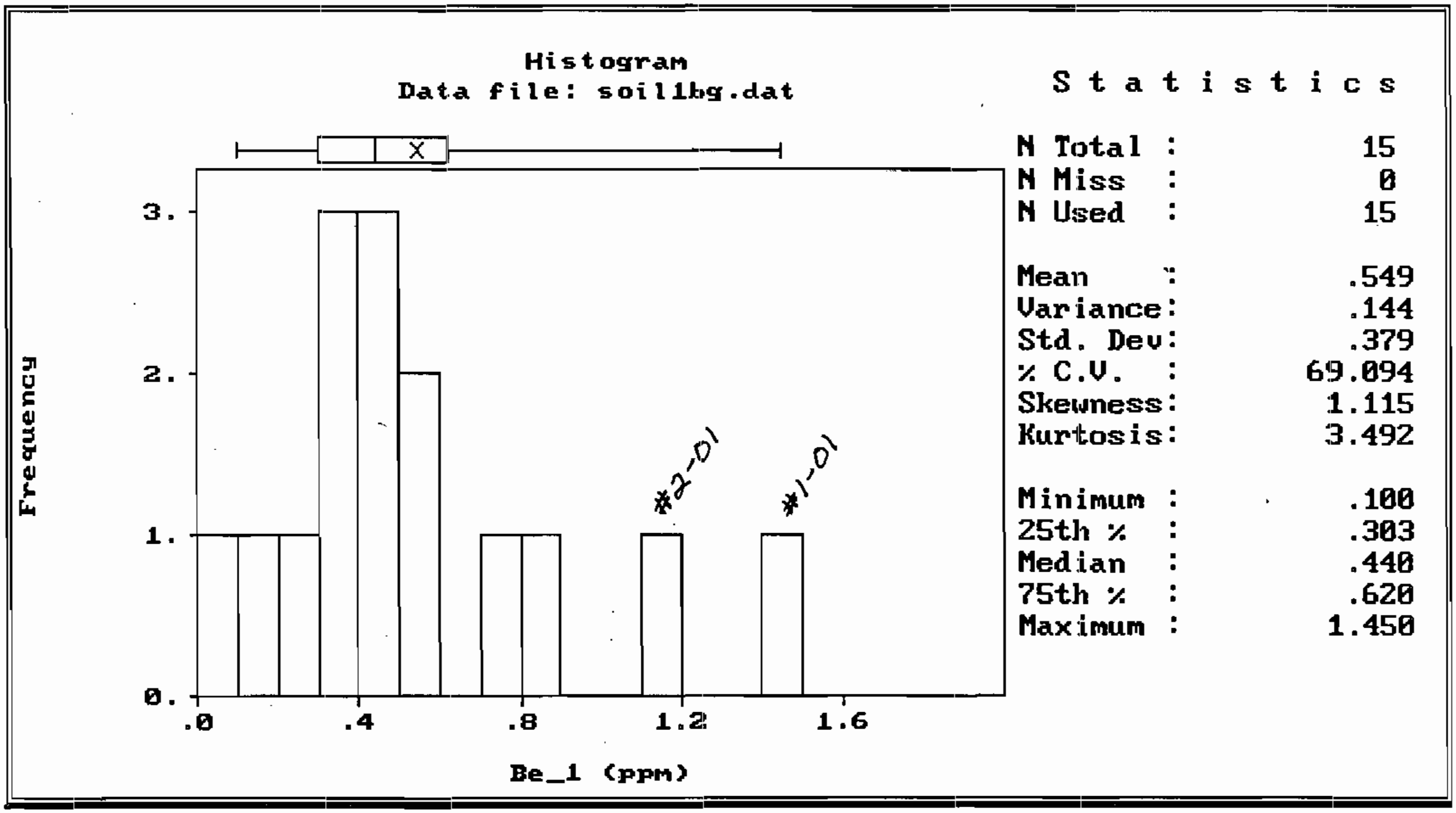
N Total :	15
N Miss :	3
N Used :	12
Mean :	9.158
Variance:	.052
Std. Dev:	.228
% C.V. :	2.487
Skewness:	-.332
Kurtosis:	1.934
Minimum :	8.751
25th % :	8.929
Median :	9.216
75th % :	9.324
Maximum :	9.480

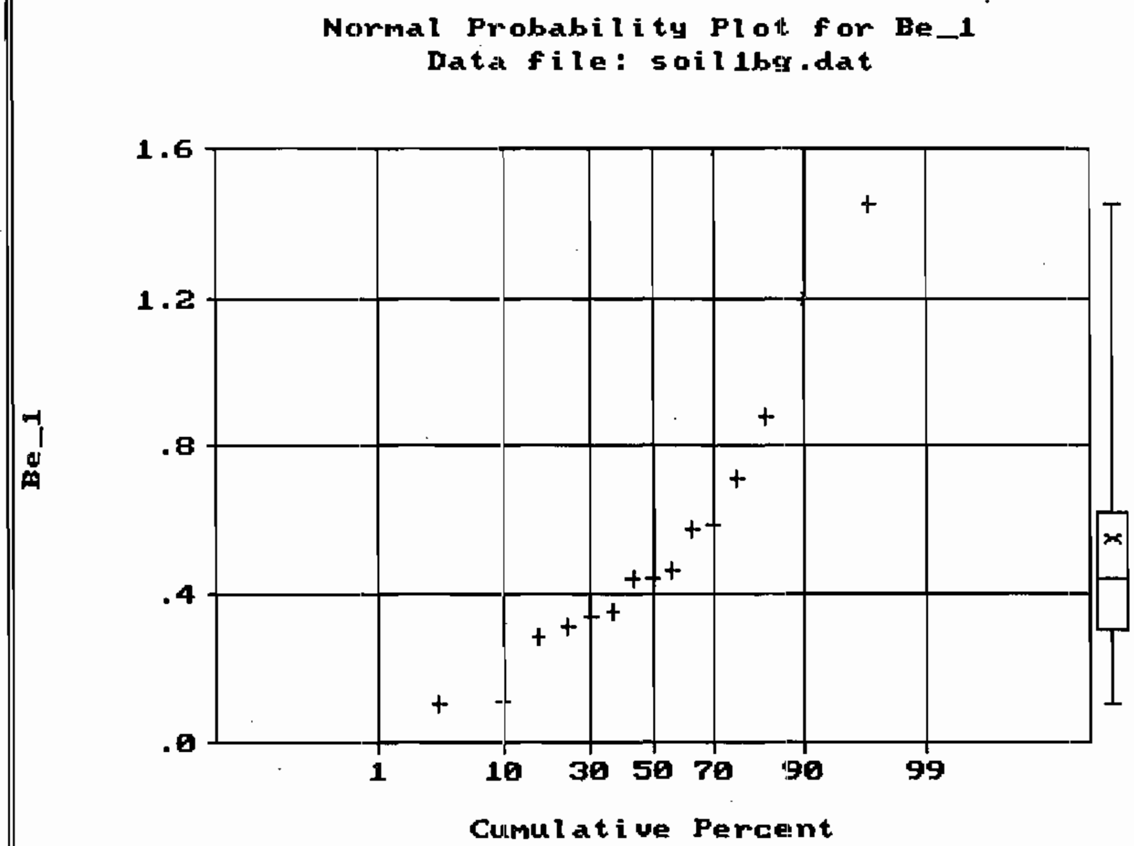


Statistics

N Total	:	15
N Miss	:	3
N Used	:	12
Mean	:	9.158
Variance	:	.052
Std. Dev	:	.228
% C.V.	:	2.487
Skewness	:	-.332
Kurtosis	:	1.934
Minimum	:	8.751
25th %	:	8.929
Median	:	9.216
75th %	:	9.324
Maximum	:	9.480

Zone B
Beryllium in surface soil grid samples
Original dataset (N=15)
Original values

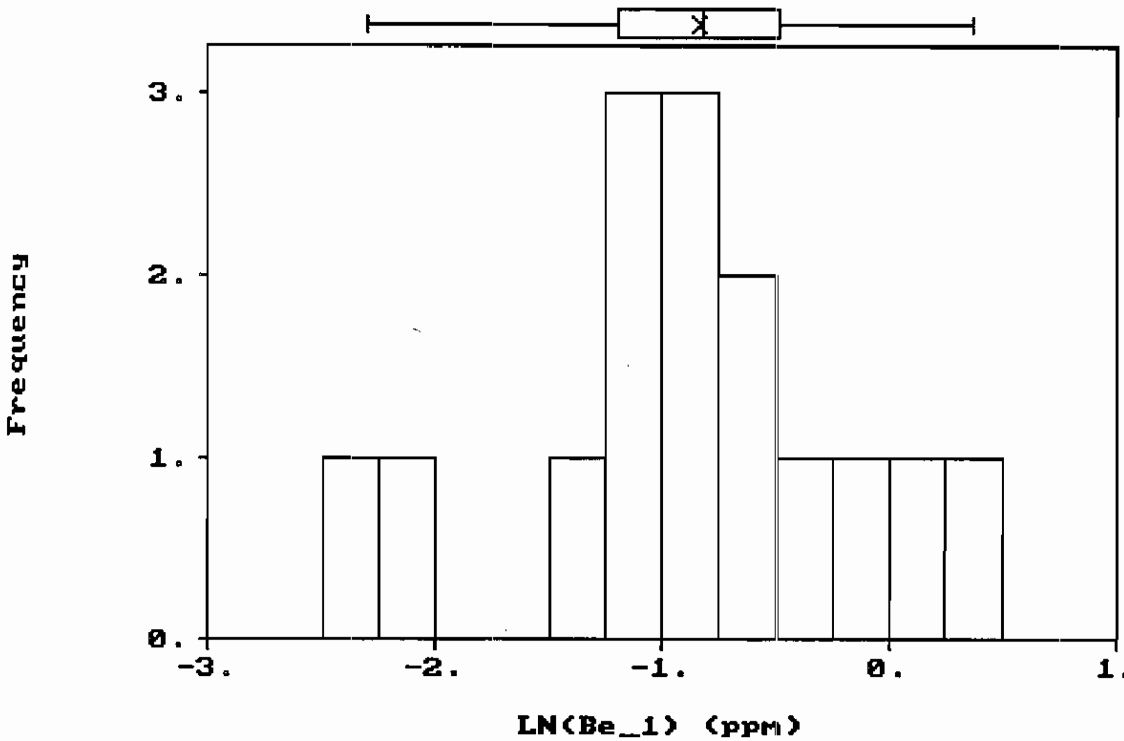




S t a t i s t i c s

N Total :	15
N Miss :	0
N Used :	15
Mean :	.549
Variance:	.144
Std. Dev:	.379
% C.V. :	69.094
Skewness:	1.115
Kurtosis:	3.492
Minimum :	.100
25th % :	.303
Median :	.440
75th % :	.620
Maximum :	1.450

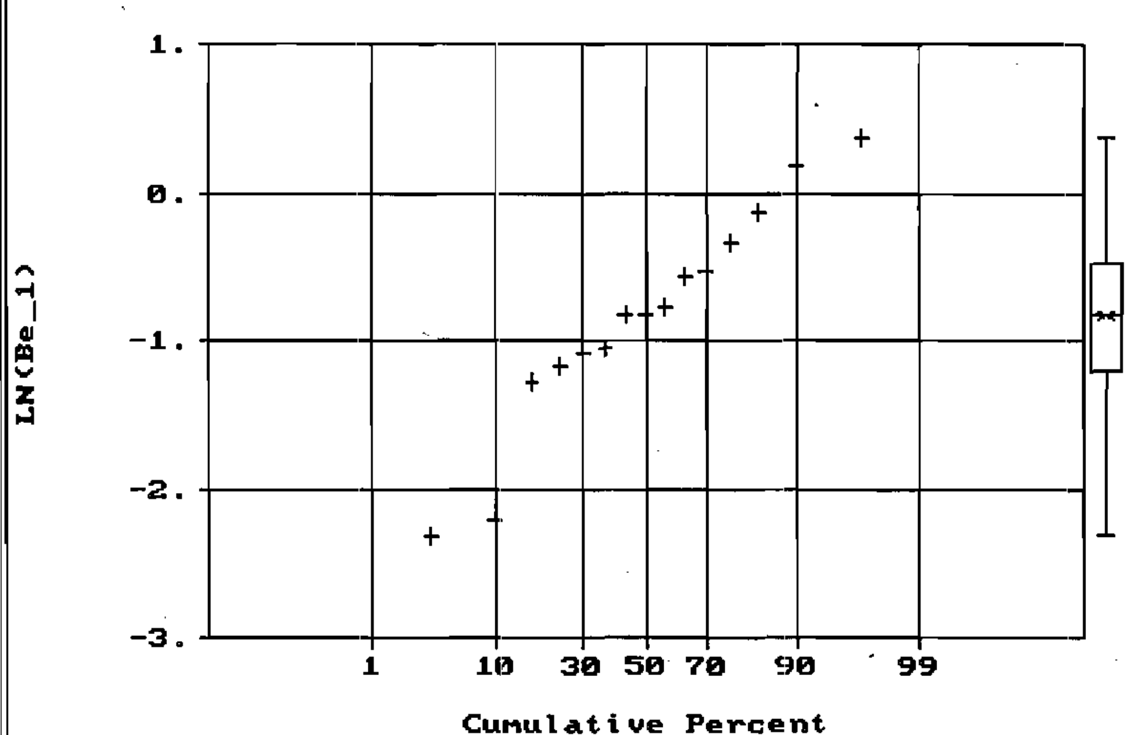
Zone B
BE in surface soil grid samples
Original dataset (N = 15)
LN - transformed values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	-.834
Variance:	.561
Std. Dev:	.749
% C.V. :	89.824
Skewness:	-.455
Kurtosis:	2.862
Minimum :	-2.303
25th % :	-1.197
Median :	-.821
75th % :	-.481
Maximum :	.372

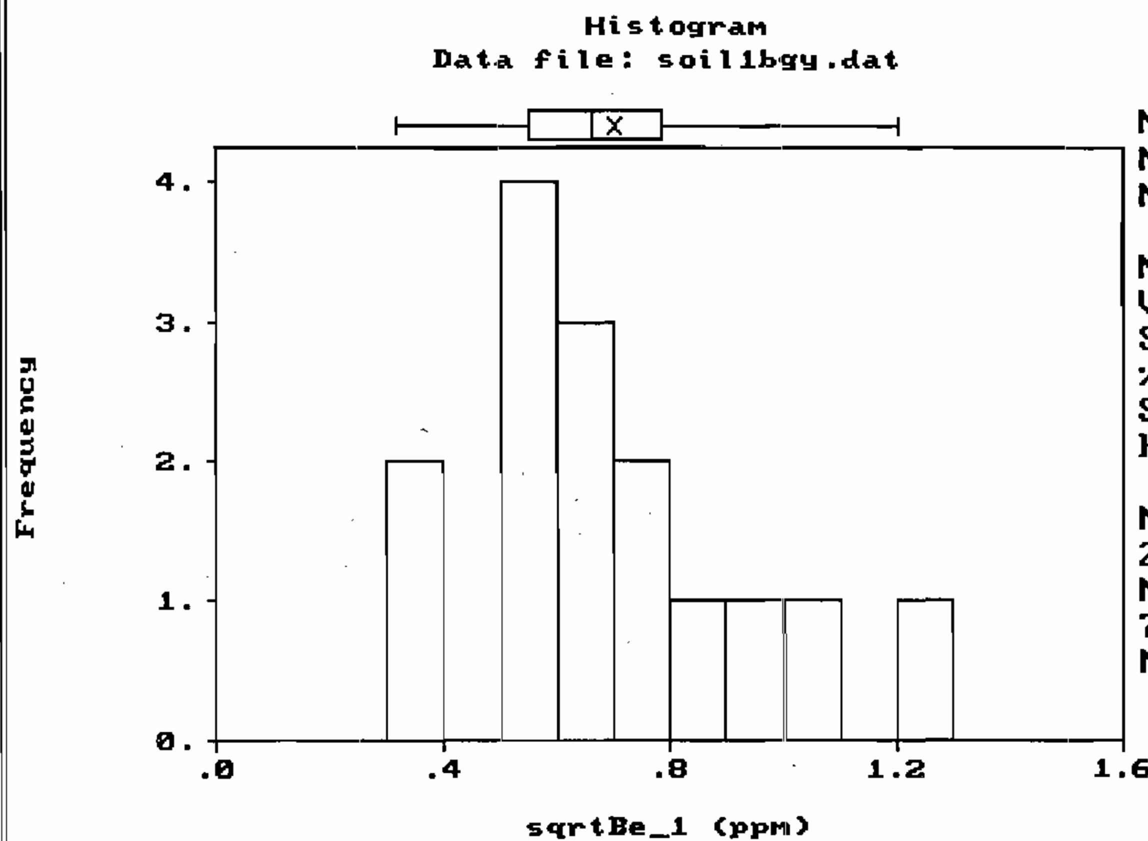
Normal Probability Plot for LN(Be_1)
Data file: soil1bg.dat



Statistics

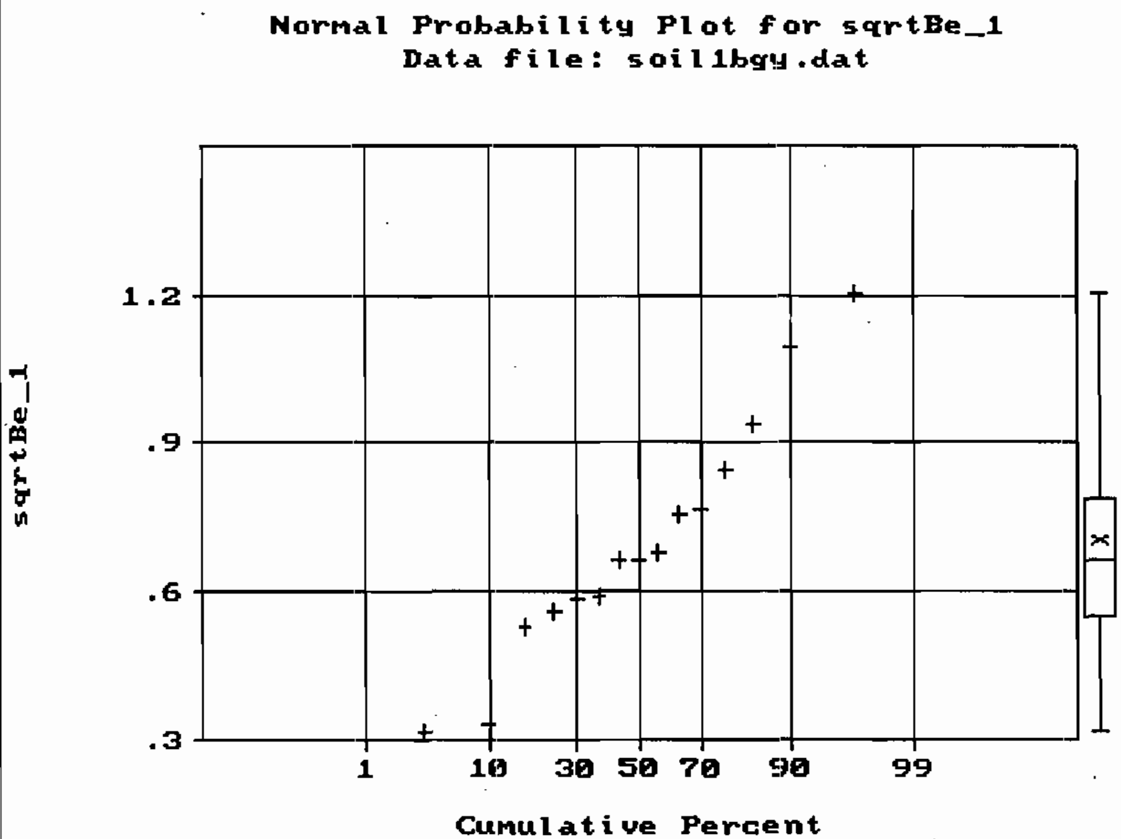
N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	-.834
Variance	:	.561
Std. Dev	:	.749
% C.V.	:	89.824
Skewness	:	-.455
Kurtosis	:	2.862
Minimum	:	-2.303
25th %	:	-1.197
Median	:	-.821
75th %	:	-.481
Maximum	:	.372

Zone B
BE in surface soil grid samples
Original dataset (N=15)
Square-root transformed values



Statistics

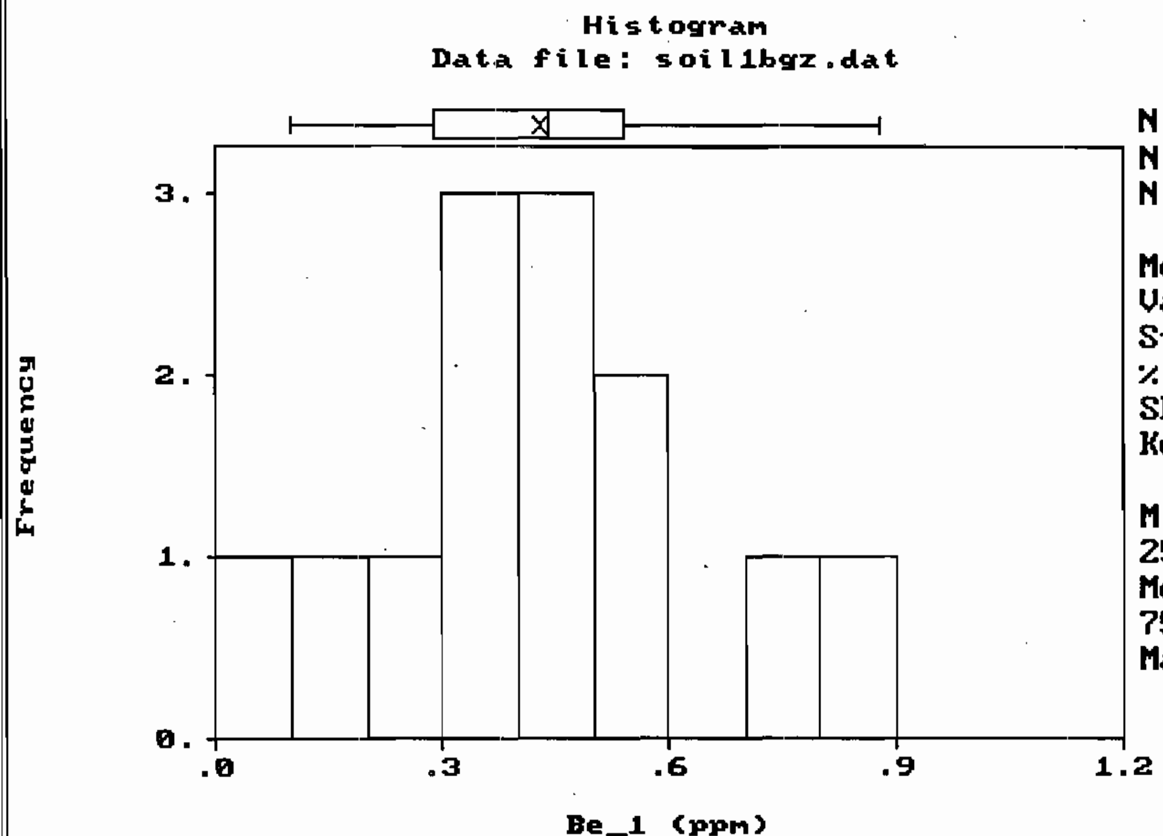
N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	.701
Variance	:	.061
Std. Dev	:	.247
% C.V.	:	35.277
Skewness	:	.423
Kurtosis	:	2.741
Minimum	:	.316
25th %	:	.550
Median	:	.663
75th %	:	.787
Maximum	:	1.204



S t a t i s t i c s

N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	.701
Variance	:	.061
Std. Dev	:	.247
% C.V.	:	35.277
Skewness	:	.423
Kurtosis	:	2.741
Minimum	:	.316
25th %	:	.550
Median	:	.663
75th %	:	.787
Maximum	:	1.204

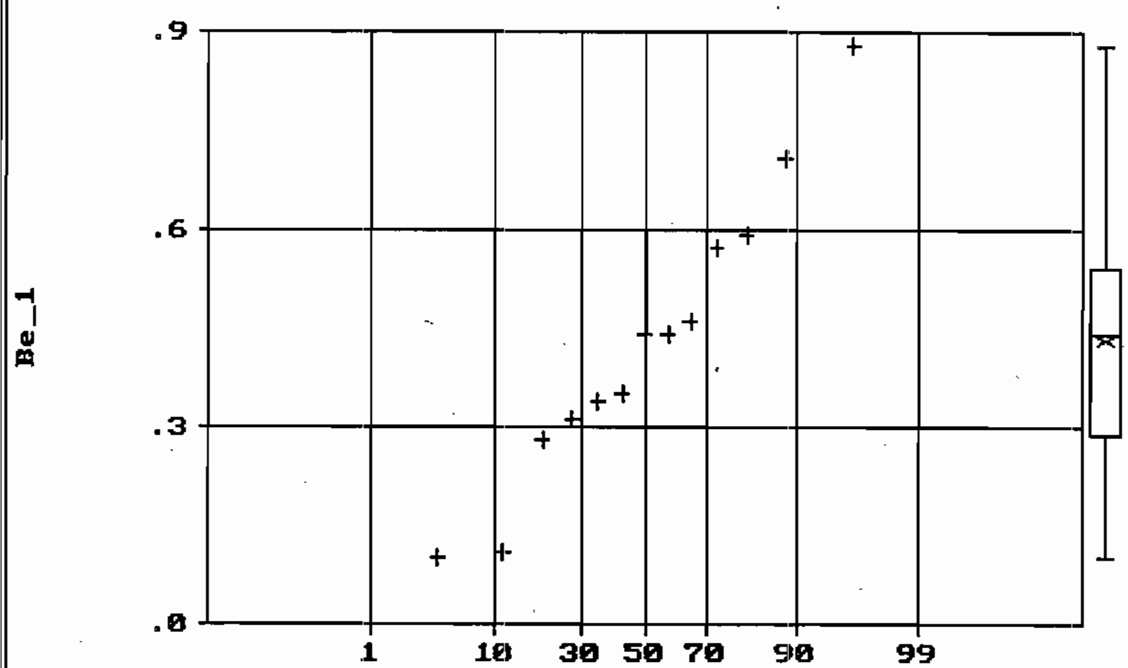
Zone B
BE in surface soil grid samples
Samples #1-01 and 2-01 removed (N=13)
Original values



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	.429
Variance:	.049
Std. Dev:	.222
% C.V. :	51.654
Skewness:	.368
Kurtosis:	2.671
Minimum :	.100
25th % :	.287
Median :	.440
75th % :	.543
Maximum :	.880

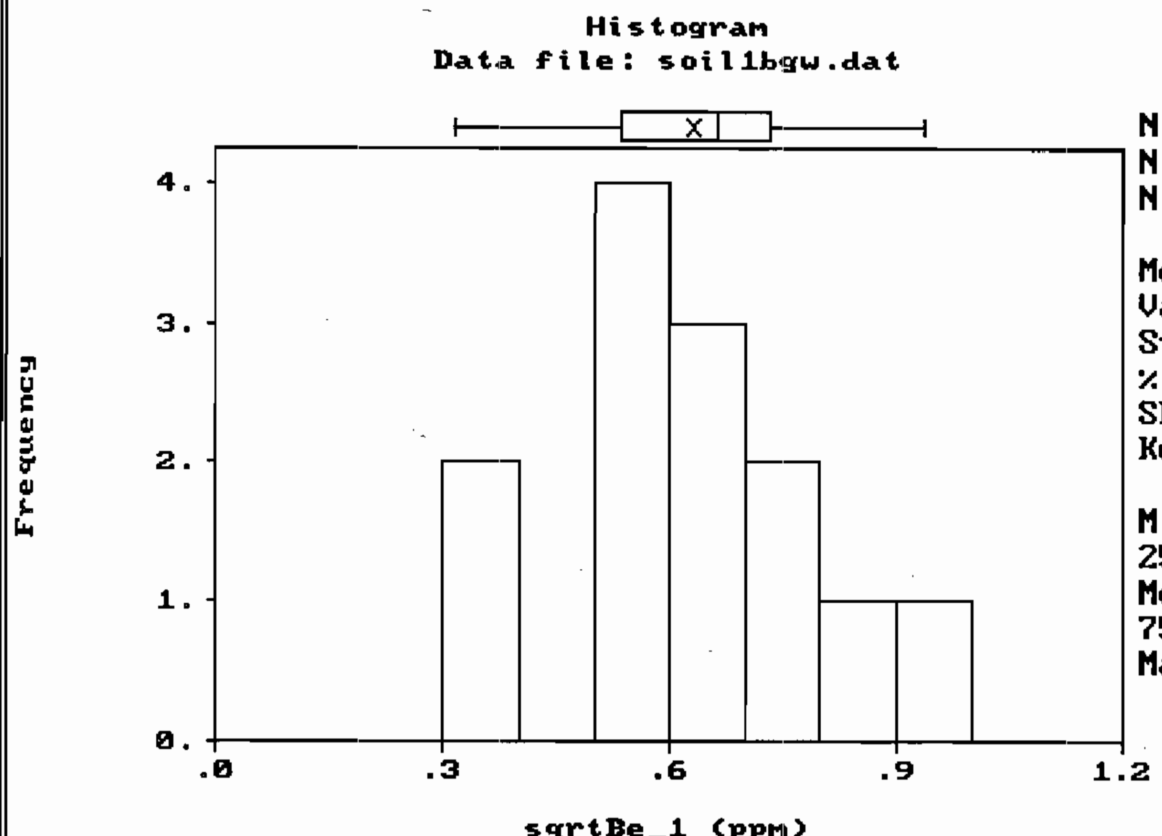
Normal Probability Plot for Be_1
Data file: soil1bgz.dat



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	.429
Variance:	.049
Std. Dev:	.222
% C.V. :	51.654
Skewness:	.368
Kurtosis:	2.671
Minimum :	.100
25th % :	.287
Median :	.440
75th % :	.543
Maximum :	.880

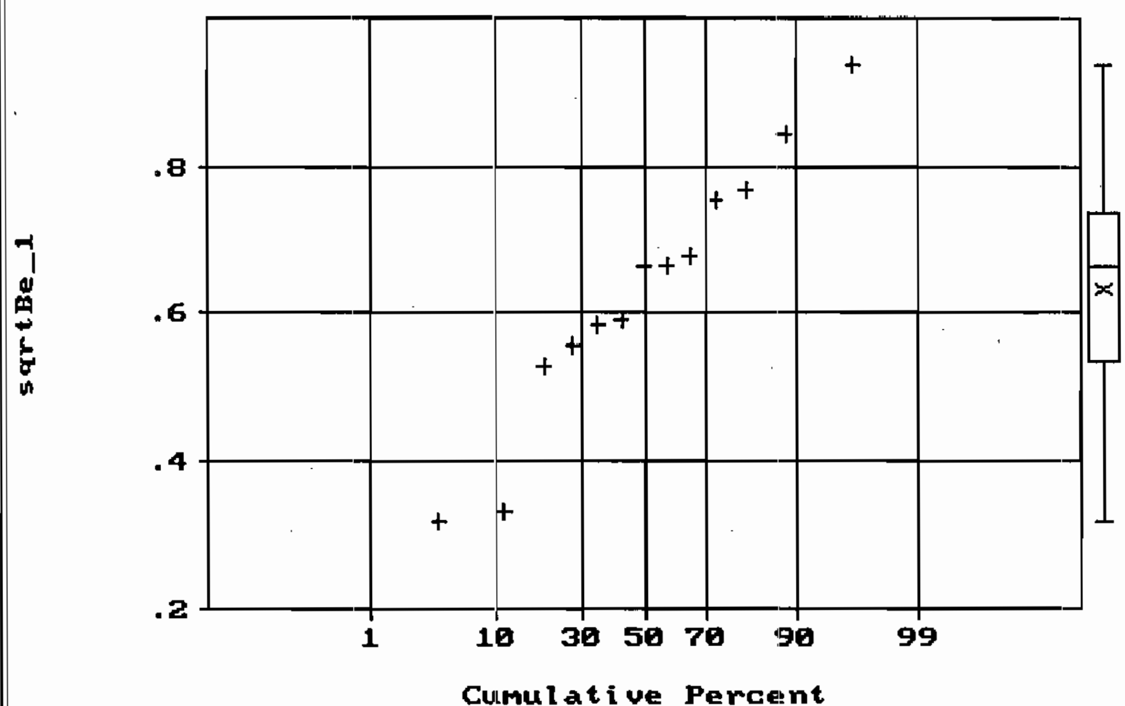
Zone B
BE in surface soil grid samples
Samples #1-01 and 2-01 removed
Square-root transformed values



Statistics

N Total	:	13
N Miss	:	0
N Used	:	13
Mean	:	.632
Variance	:	.032
Std. Dev	:	.179
% C.V.	:	28.373
Skewness	:	-.268
Kurtosis	:	2.580
Minimum	:	.316
25th %	:	.536
Median	:	.663
75th %	:	.736
Maximum	:	.938

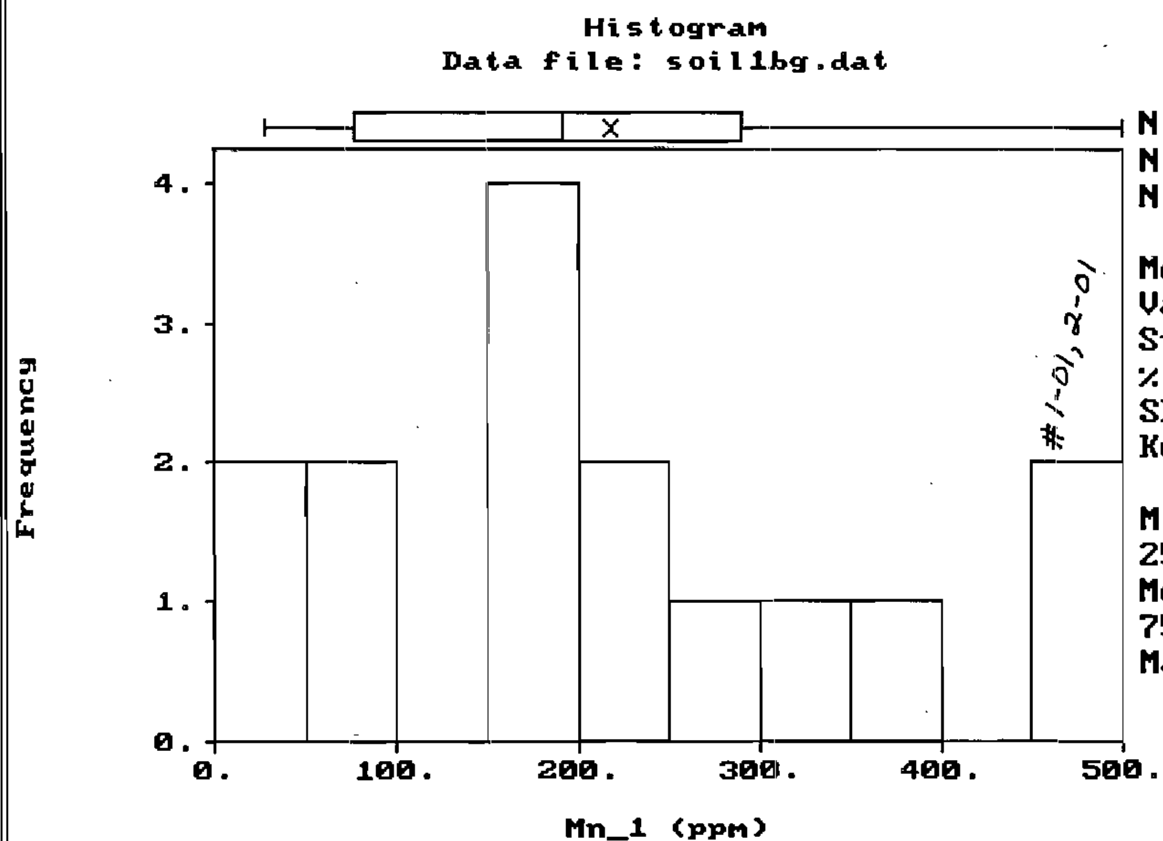
Normal Probability Plot for sqrtBe_1
Data file: soil1bgw.dat



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	.632
Variance:	.032
Std. Dev:	.179
% C.V. :	28.373
Skewness:	-.268
Kurtosis:	2.580
Minimum :	.316
25th % :	.536
Median :	.663
75th % :	.736
Maximum :	.938

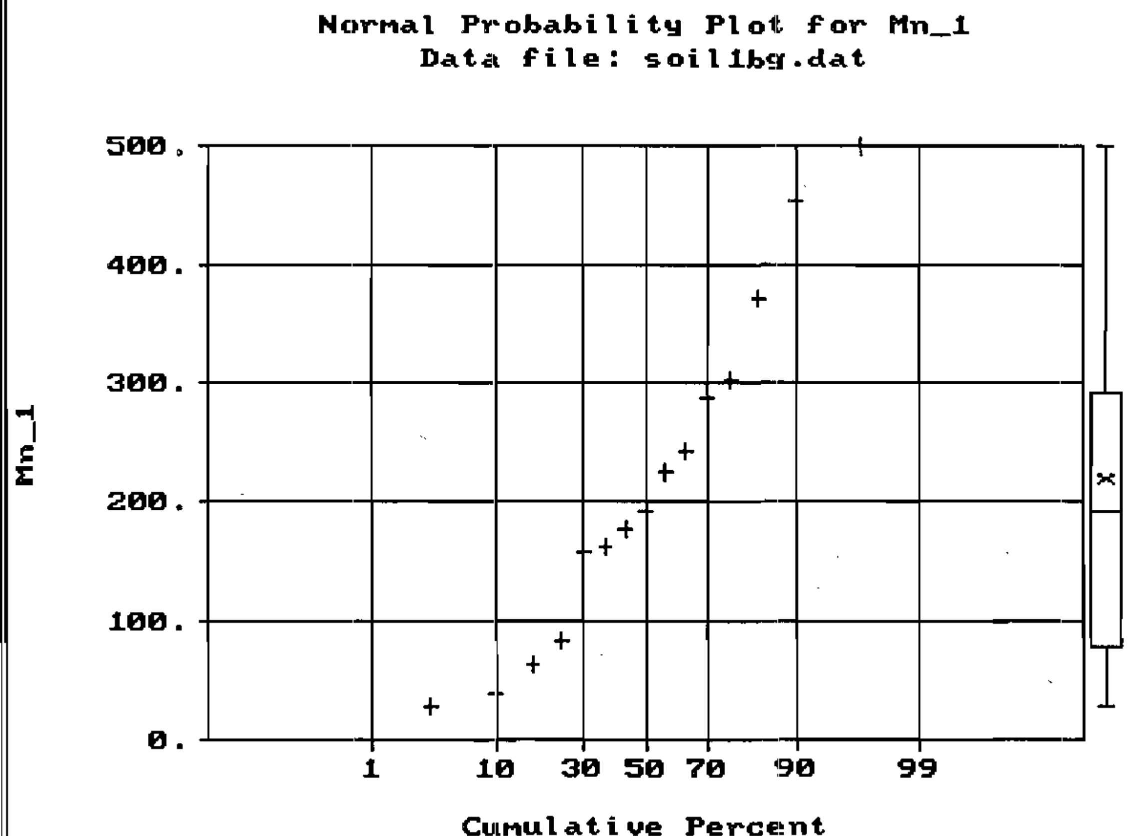
Zone B
Manganese in surface soil grid samples
Original dataset (N=15)
Original values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	218.653
Variance:	20828.200
Std. Dev:	144.320
% C.V. :	66.004
Skewness:	.493
Kurtosis:	2.348
Minimum :	27.200
25th % :	76.475
Median :	192.000
75th % :	290.750
Maximum :	500.000

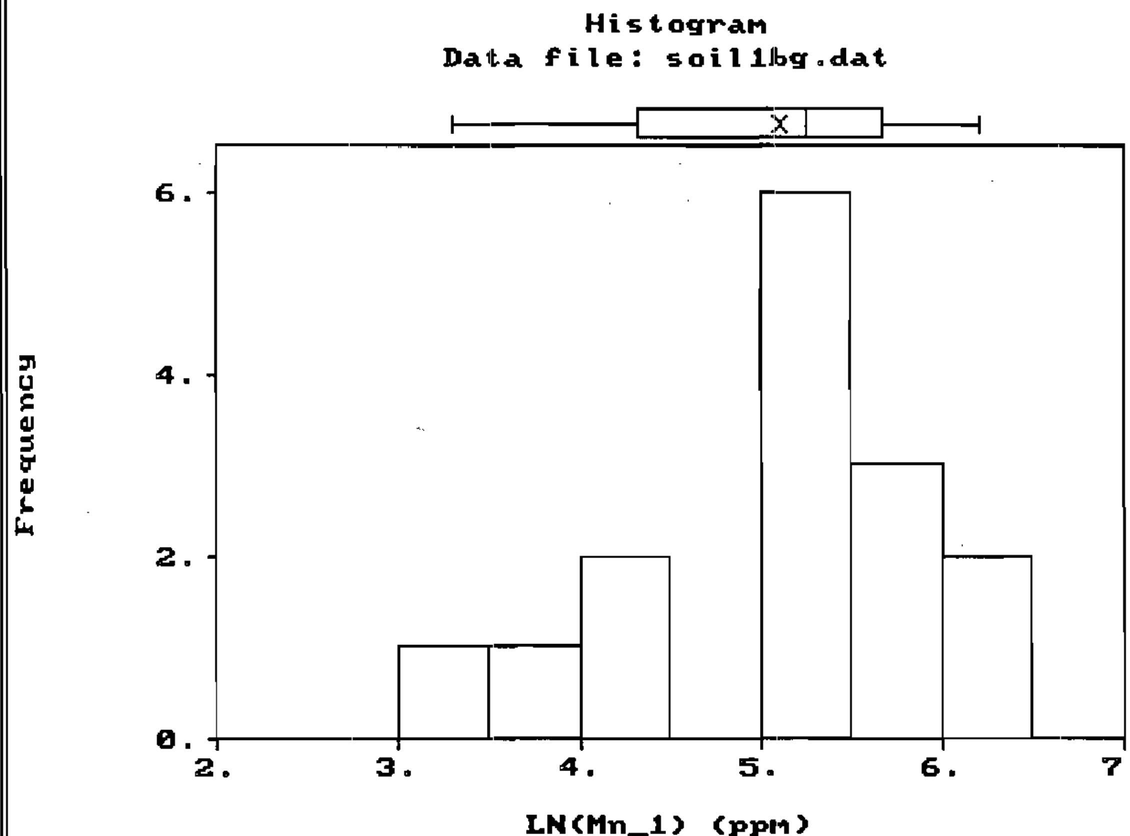
16



S t a t i s t i c s

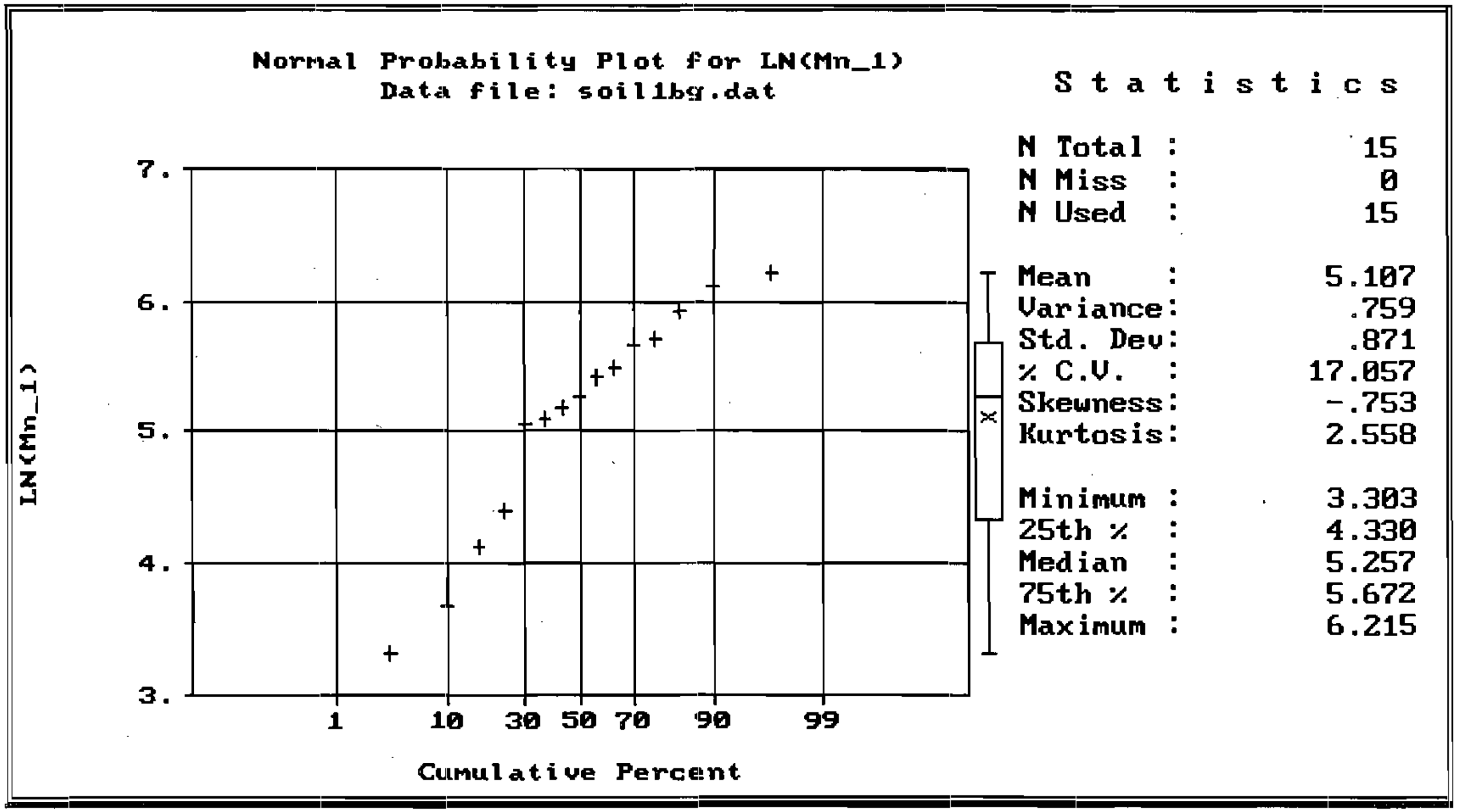
N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	218.653
Variance	:	20828.200
Std. Dev	:	144.320
% C.V.	:	66.004
Skewness	:	.493
Kurtosis	:	2.348
Minimum	:	27.200
25th %	:	76.475
Median	:	192.000
75th %	:	290.750
Maximum	:	500.000

Zone B
MN in surface soil grid samples
Original dataset (N=15)
LN-transformed values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	5.107
Variance:	.759
Std. Dev:	.871
% C.V. :	17.057
Skewness:	-.753
Kurtosis:	2.558
Minimum :	3.303
25th % :	4.330
Median :	5.257
75th % :	5.672
Maximum :	6.215

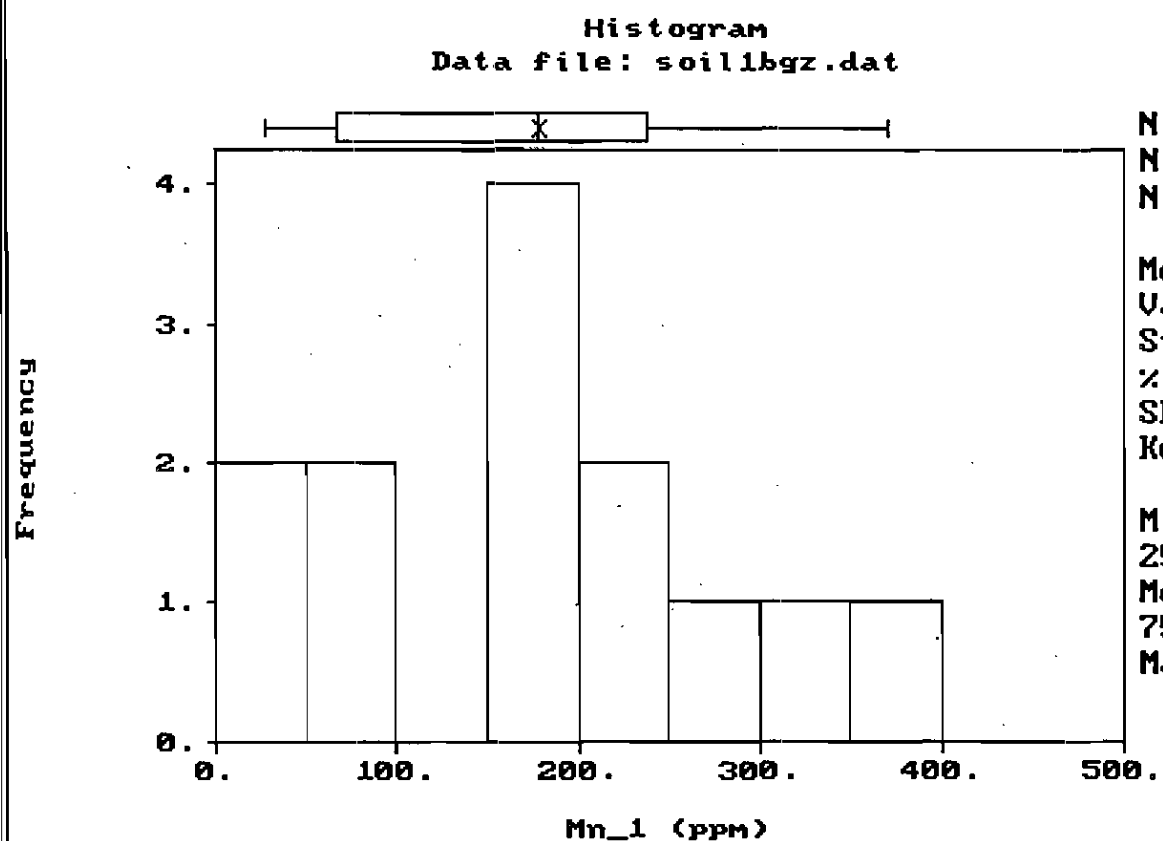

Normal Probability Plot for LN(Mn_1)
Data file: soil1bg.dat
LN(Mn_1)
7.
6.
5.
4.
3.
1
10
30
50
70
90
99
Cumulative Percent
Statistics
N Total : 15
N Miss : 0
N Used : 15
Mean : 5.107
Variance: .759
Std. Dev: .871
% C.V. : 17.057
Skewness: -.753
Kurtosis: 2.558
Minimum : 3.303
25th % : 4.330
Median : 5.257
75th % : 5.672
Maximum : 6.215

Zone B

MN in surface soil grid samples

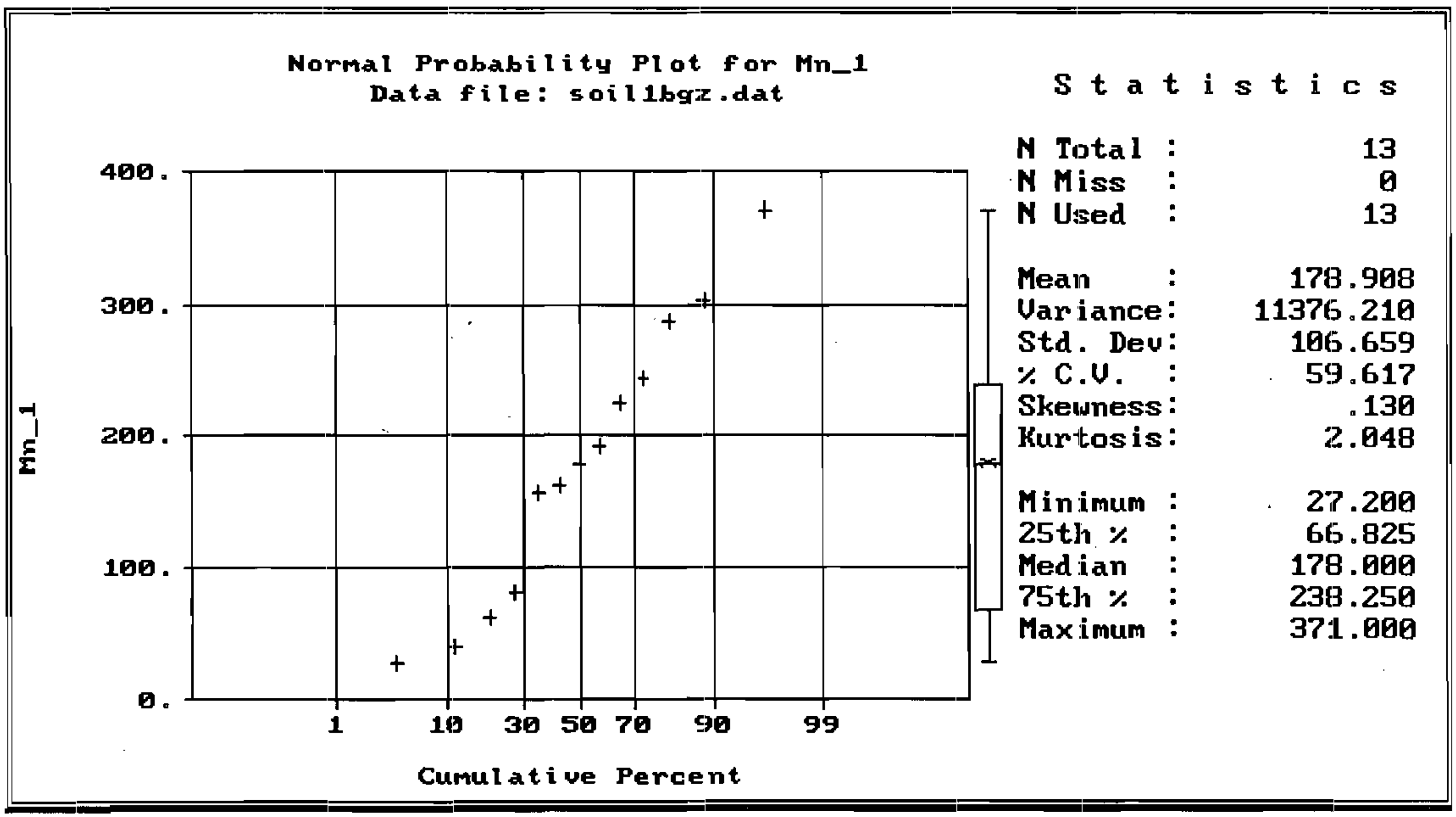
Samples # 1-01 and 2-01 removed

Original values

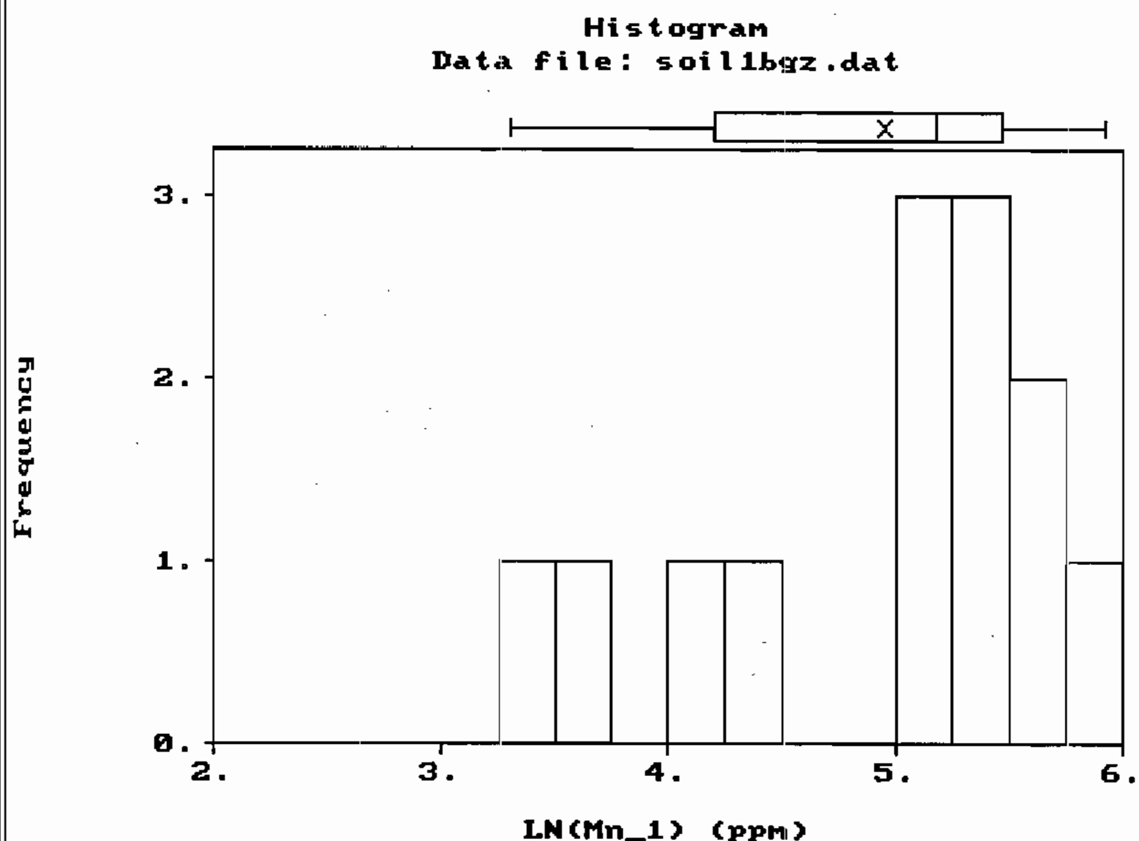


Statistics

N Total	:	13
N Miss	:	0
N Used	:	13
Mean	:	178.908
Variance	:	11376.210
Std. Dev	:	106.659
% C.V.	:	59.617
Skewness	:	.130
Kurtosis	:	2.048
Minimum	:	27.200
25th %	:	66.825
Median	:	178.000
75th %	:	238.250
Maximum	:	371.000


Normal Probability Plot for Mn_1
Data file: soil1bgz.dat
Mn_1
400.
300.
200.
100.
0.
1
10
30
50
70
90
99
Cumulative Percent
S t a t i s t i c s
N Total : 13
N Miss : 0
N Used : 13
Mean : 178.908
Variance: 11376.210
Std. Dev: 106.659
% C.V. : 59.617
Skewness: .130
Kurtosis: 2.048
Minimum : 27.200
25th % : 66.825
Median : 178.000
75th % : 238.250
Maximum : 371.000

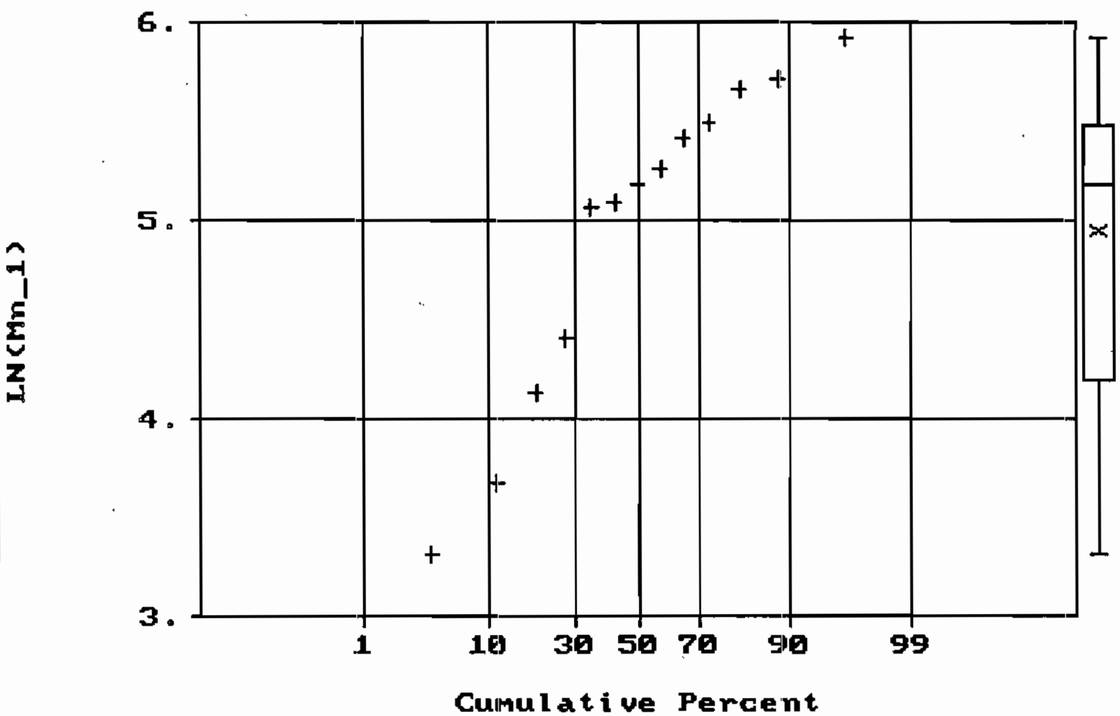
Zone B
MN in surface soil grid samples
Samples #1-01 and 2-01 removed
LN-transformed values



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	4.944
Variance:	.669
Std. Dev:	.818
% C.V. :	16.545
Skewness:	-.814
Kurtosis:	2.432
Minimum :	3.303
25th % :	4.195
Median :	5.182
75th % :	5.473
Maximum :	5.916

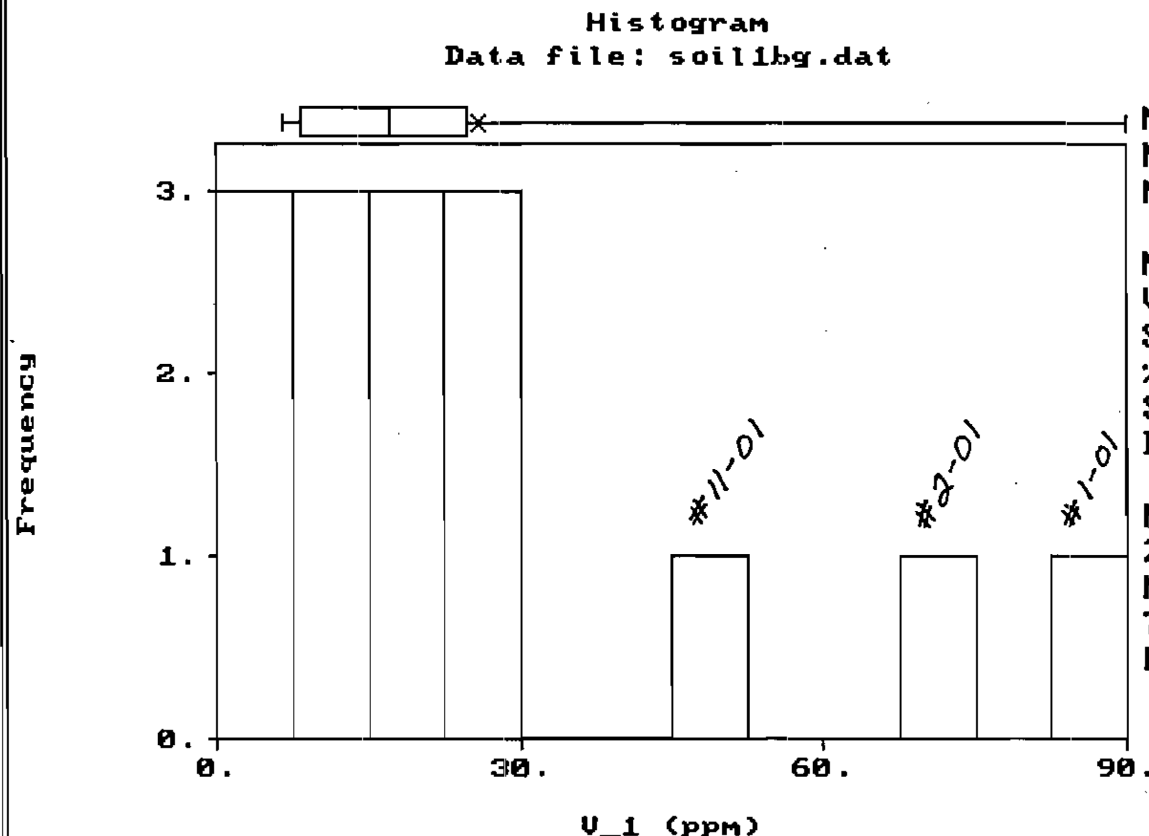
Normal Probability Plot for LN(Mn_1)
Data file: soil1bgz.dat



S t a t i s t i c s

N Total	:	13
N Miss	:	0
N Used	:	13
Mean	:	4.944
Variance	:	.669
Std. Dev	:	.818
% C.V.	:	16.545
Skewness	:	-.814
Kurtosis	:	2.432
Minimum	:	3.303
25th %	:	4.195
Median	:	5.182
75th %	:	5.473
Maximum	:	5.916

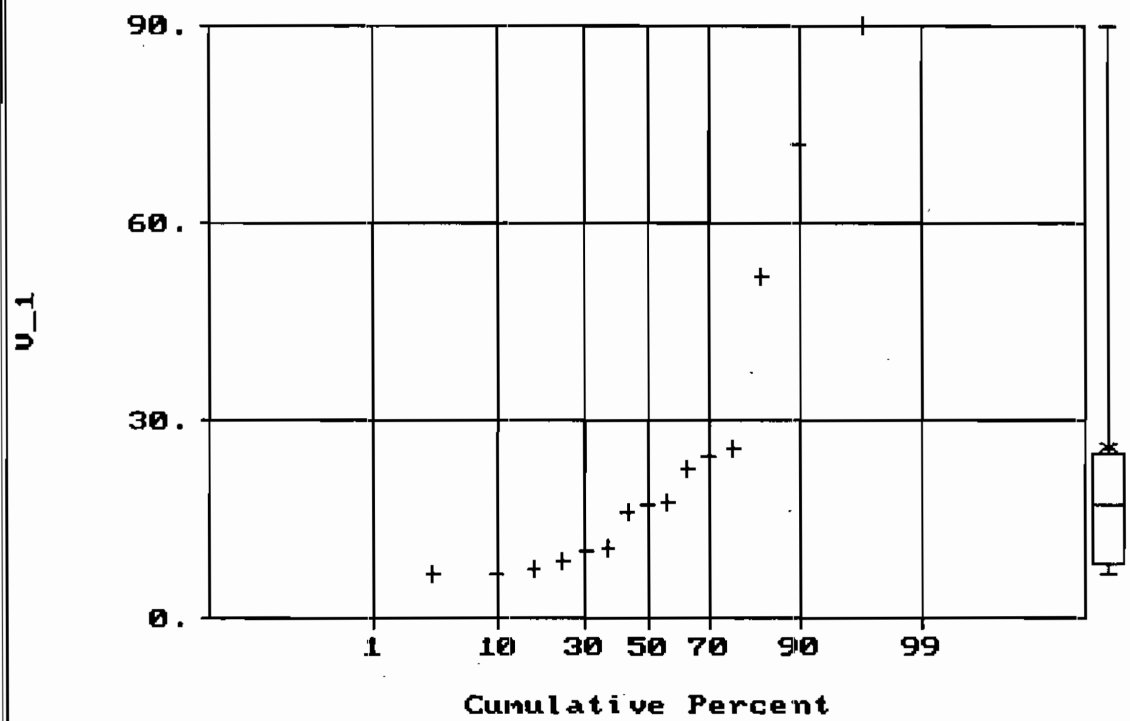
Zone B
Vanadium in surface soil grid samples
Original dataset (N=15)
Original values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	25.727
Variance:	645.253
Std. Dev:	25.402
% C.V. :	98.737
Skewness:	1.558
Kurtosis:	4.157
Minimum :	6.500
25th % :	8.238
Median :	17.000
75th % :	24.775
Maximum :	89.950

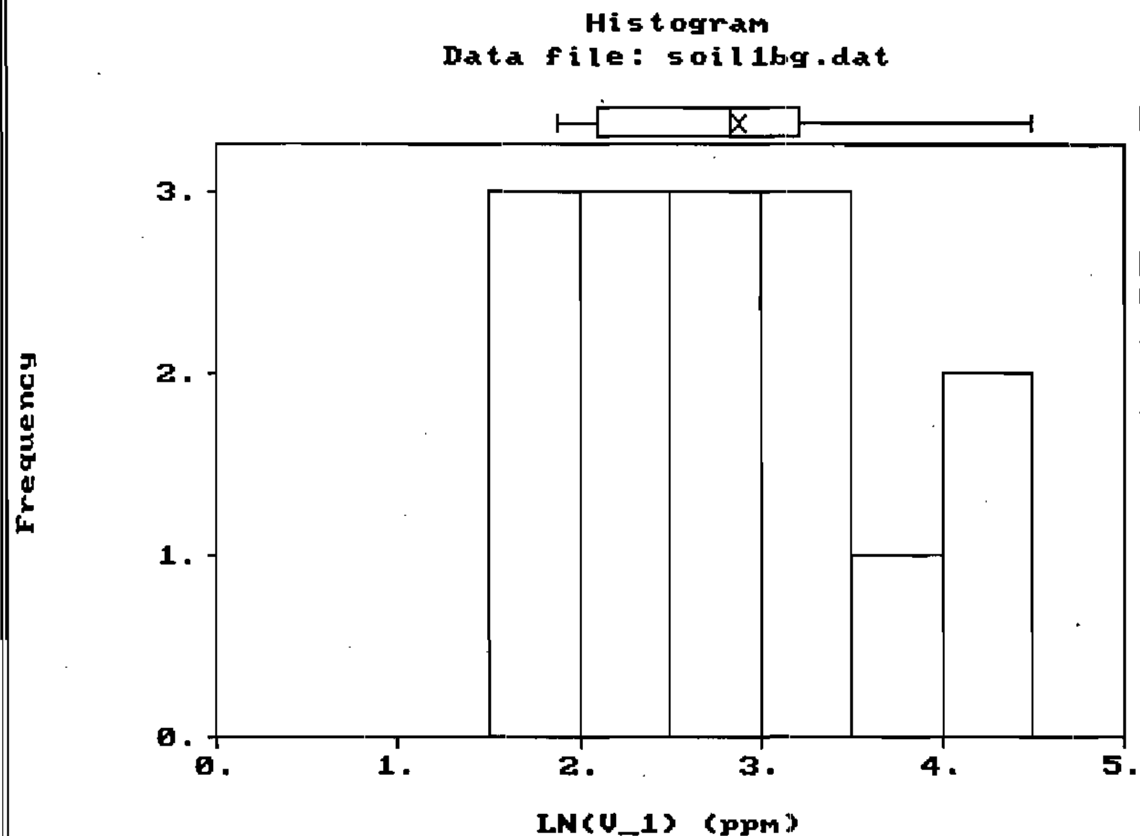
Normal Probability Plot for V_1
Data file: soil1bg.dat



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	25.727
Variance:	645.253
Std. Dev:	25.402
% C.V. :	98.737
Skewness:	1.558
Kurtosis:	4.157
Minimum :	6.500
25th % :	8.238
Median :	17.000
75th % :	24.775
Maximum :	89.950

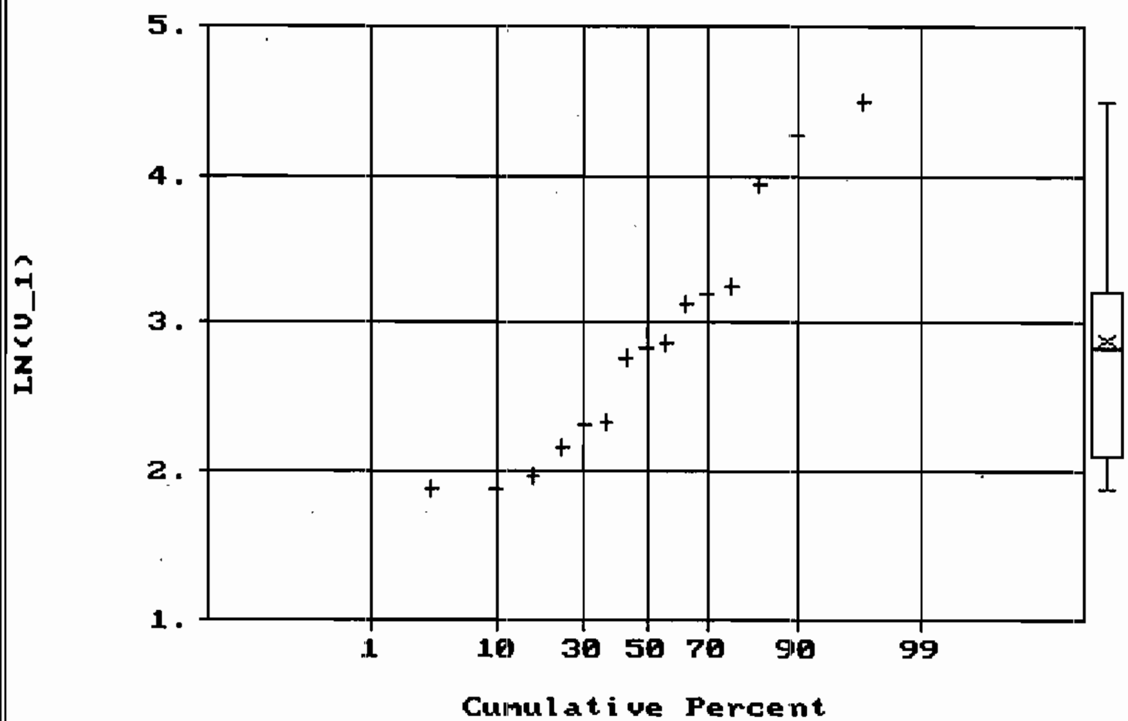
Zone B
V in surface soil grid samples
Original dataset (N=15)
LN-transformed values



S t a t i s t i c s

N Total :	15
N Miss :	0
N Used :	15
Mean :	2.884
Variance:	.714
Std. Dev:	.845
% C.V. :	29.296
Skewness:	.567
Kurtosis:	2.262
Minimum :	1.872
25th % :	2.106
Median :	2.833
75th % :	3.210
Maximum :	4.499

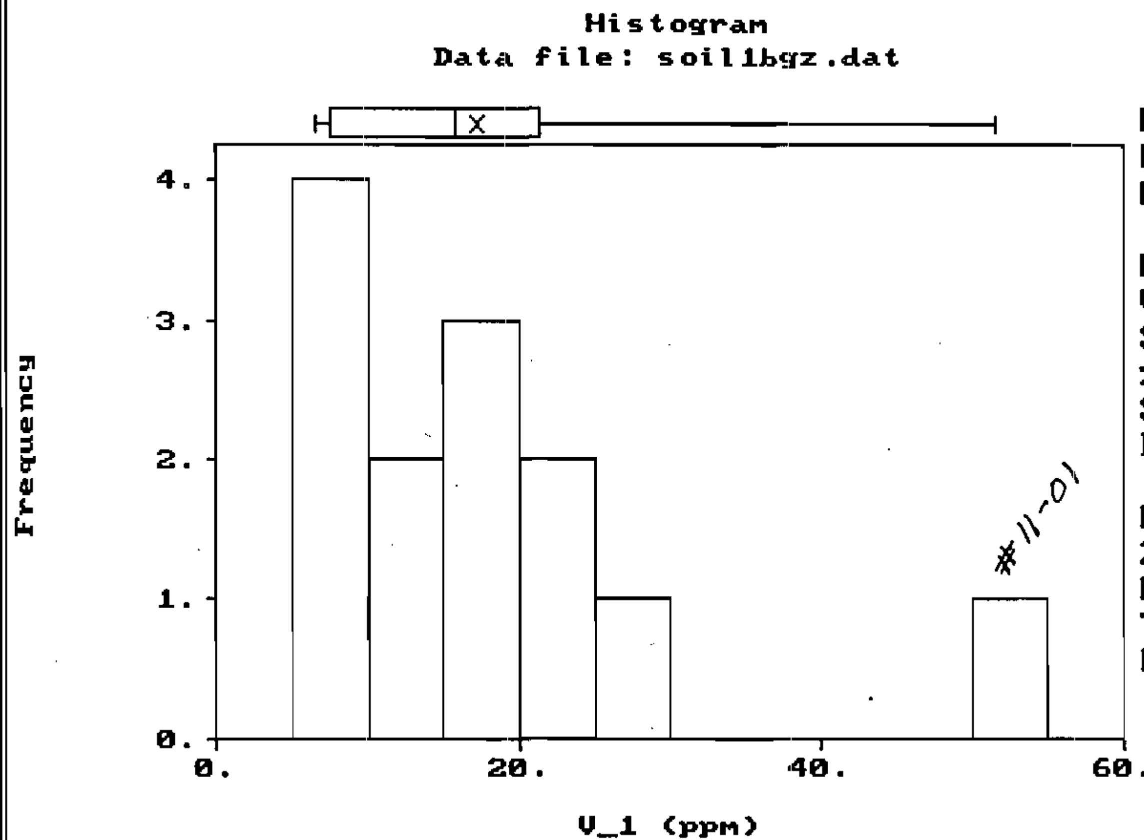
Normal Probability Plot for LN(V_1)
Data file: soil1bg.dat



S t a t i s t i c s

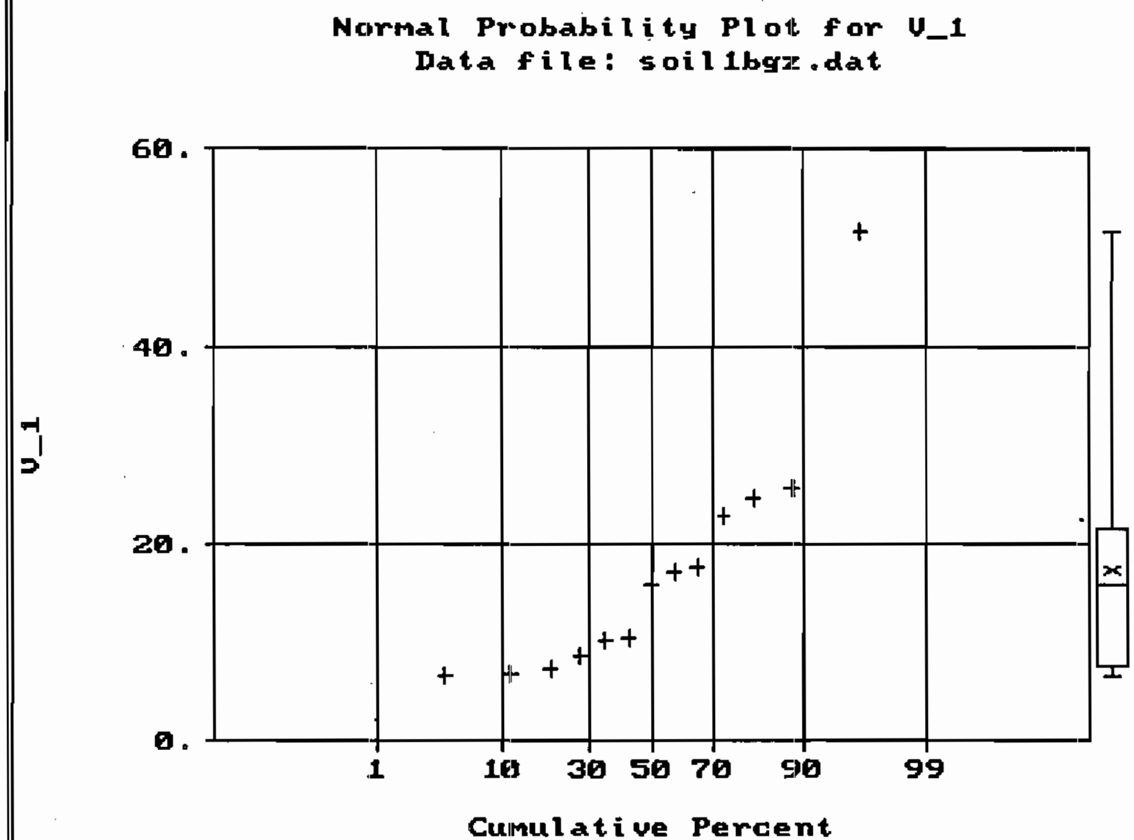
N Total :	15
N Miss :	0
N Used :	15
Mean :	2.884
Variance:	.714
Std. Dev:	.845
% C.V. :	29.296
Skewness:	.567
Kurtosis:	2.262
Minimum :	1.872
25th % :	2.106
Median :	2.833
75th % :	3.210
Maximum :	4.499

Zone B
V in surface soil grid samples
Samples #1-01 and 2-01 removed (N=13)
Original values



Statistics

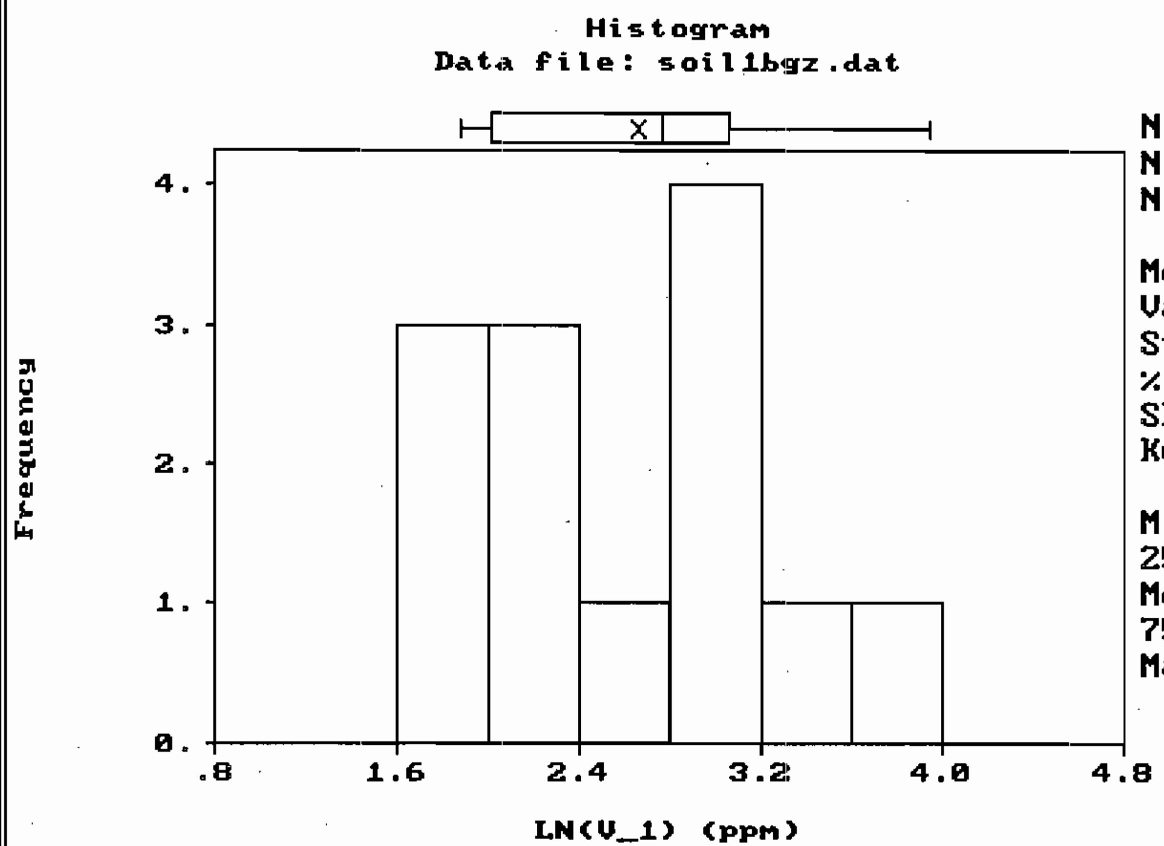
N Total :	13
N Miss :	0
N Used :	13
Mean :	17.235
Variance:	153.286
Std. Dev:	12.381
% C.V. :	71.837
Skewness:	1.687
Kurtosis:	5.572
Minimum :	6.500
25th % :	7.513
Median :	15.800
75th % :	21.425
Maximum :	51.600



S t a t i s t i c s

N Total :	13
N Miss :	0
N Used :	13
Mean :	17.235
Variance:	153.286
Std. Dev:	12.381
% C.V. :	71.837
Skewness:	1.687
Kurtosis:	5.572
Minimum :	6.500
25th % :	7.513
Median :	15.800
75th % :	21.425
Maximum :	51.600

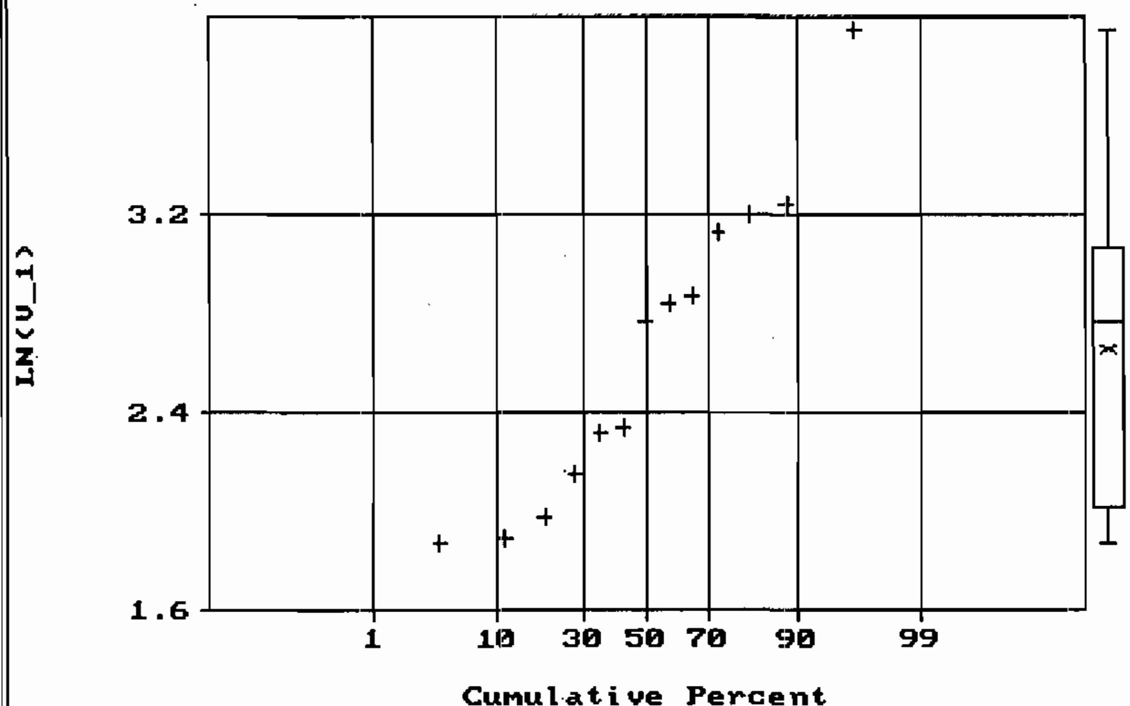
Zone B
V in surface soil grid samples
Samples #1-01 and 2-01 removed (N=13)
LN-transformed values



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	2.653
Variance:	.397
Std. Dev:	.630
% C.V. :	23.735
Skewness:	.413
Kurtosis:	2.330
Minimum :	1.872
25th % :	2.013
Median :	2.760
75th % :	3.059
Maximum :	3.944

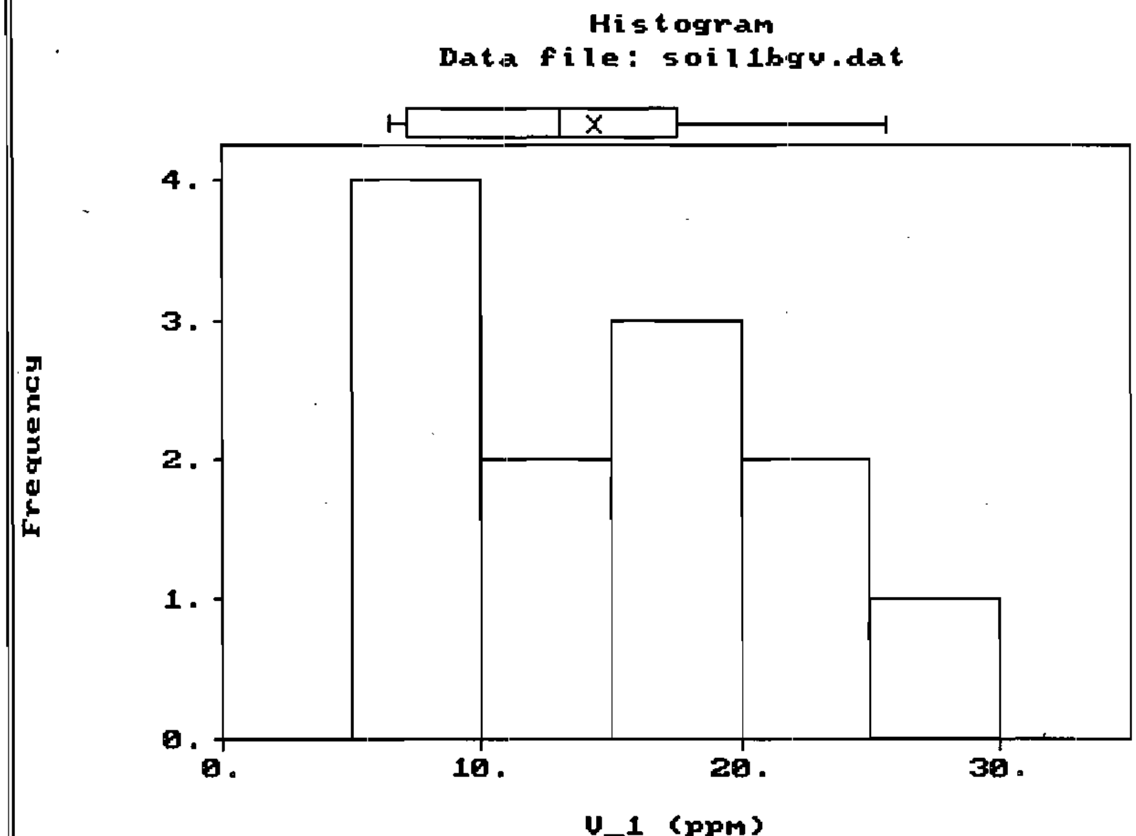
Normal Probability Plot for LN(V_1)
Data file: soil1bgz.dat



S t a t i s t i c s

N Total	:	13
N Miss	:	0
N Used	:	13
Mean	:	2.653
Variance	:	.397
Std. Dev	:	.630
% C.V.	:	23.735
Skewness	:	.413
Kurtosis	:	2.330
Minimum	:	1.872
25th %	:	2.013
Median	:	2.760
75th %	:	3.059
Maximum	:	3.944

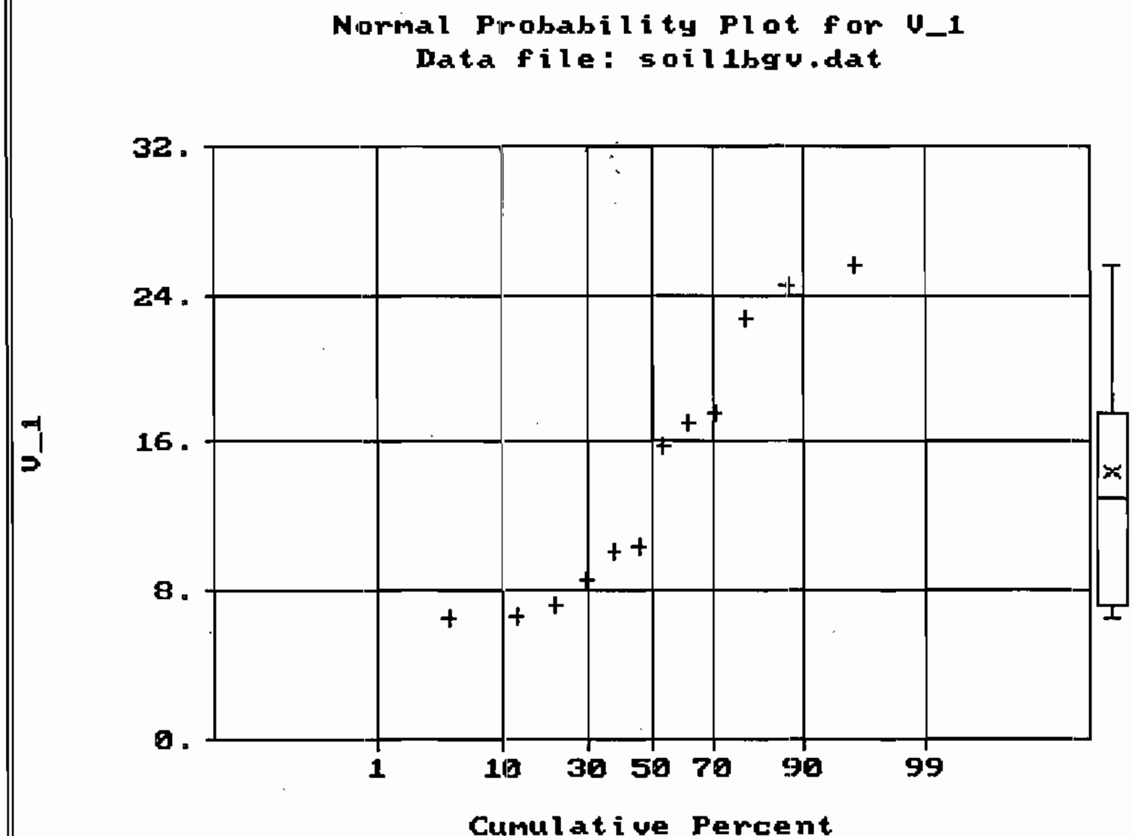
Zone B
V in surface soil grid samples
Samples # 1-01, 2-01, and 11-01 removed (N=12)
Original values



Statistics

N Total :	13
N Miss :	1
N Used :	12
Mean :	14.371
Variance:	50.913
Std. Dev:	7.135
% C.V. :	49.651
Skewness:	.370
Kurtosis:	1.657
Minimum :	6.500
25th % :	7.150
Median :	13.050
75th % :	17.600
Maximum :	25.600

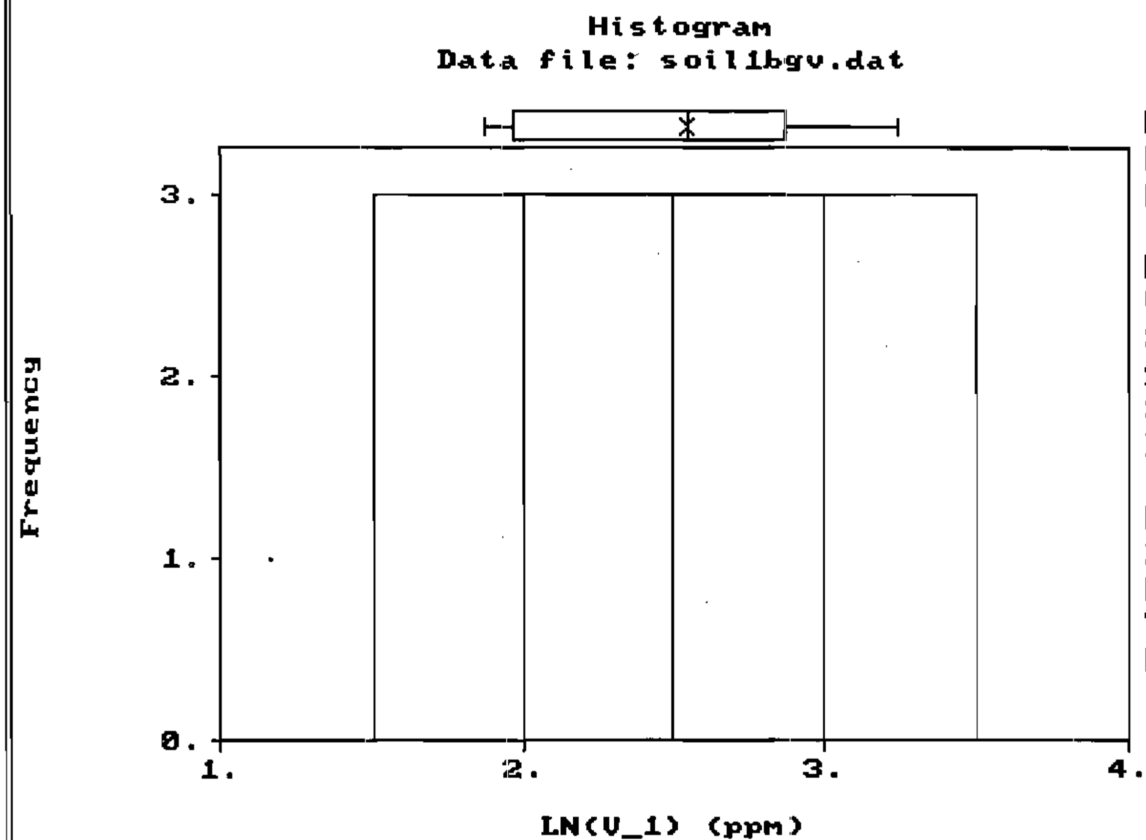
56



Statistics

N Total :	13
N Miss :	1
N Used :	12
Mean :	14.371
Variance:	50.913
Std. Dev:	7.135
% C.V. :	49.651
Skewness:	.370
Kurtosis:	1.657
Minimum :	6.500
25th % :	7.150
Median :	13.050
75th % :	17.600
Maximum :	25.600

Zone B
V in surface soil grid samples
Samples #1-01, 2-01, and 11-01 removed (N=12)
LN- transformed values



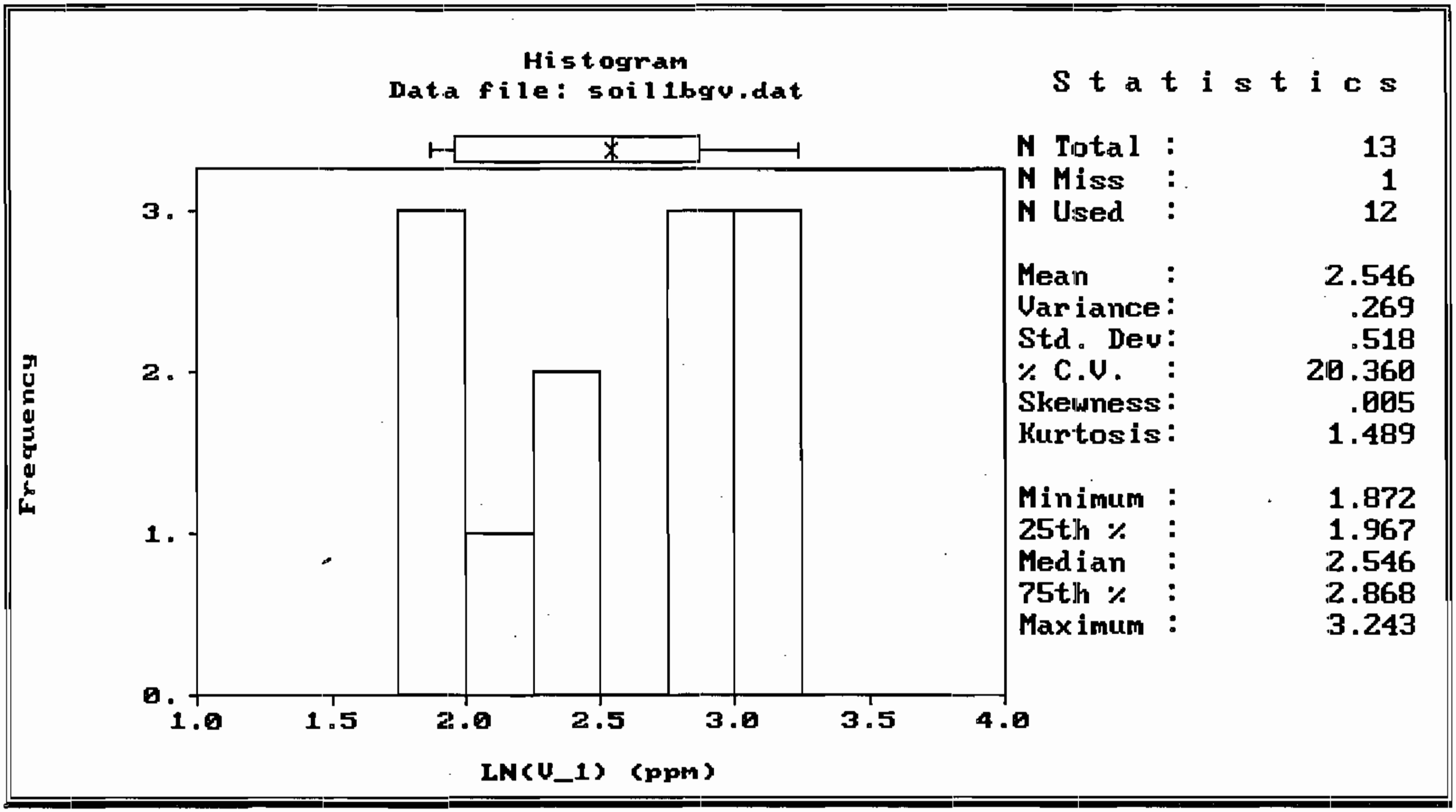
Statistics

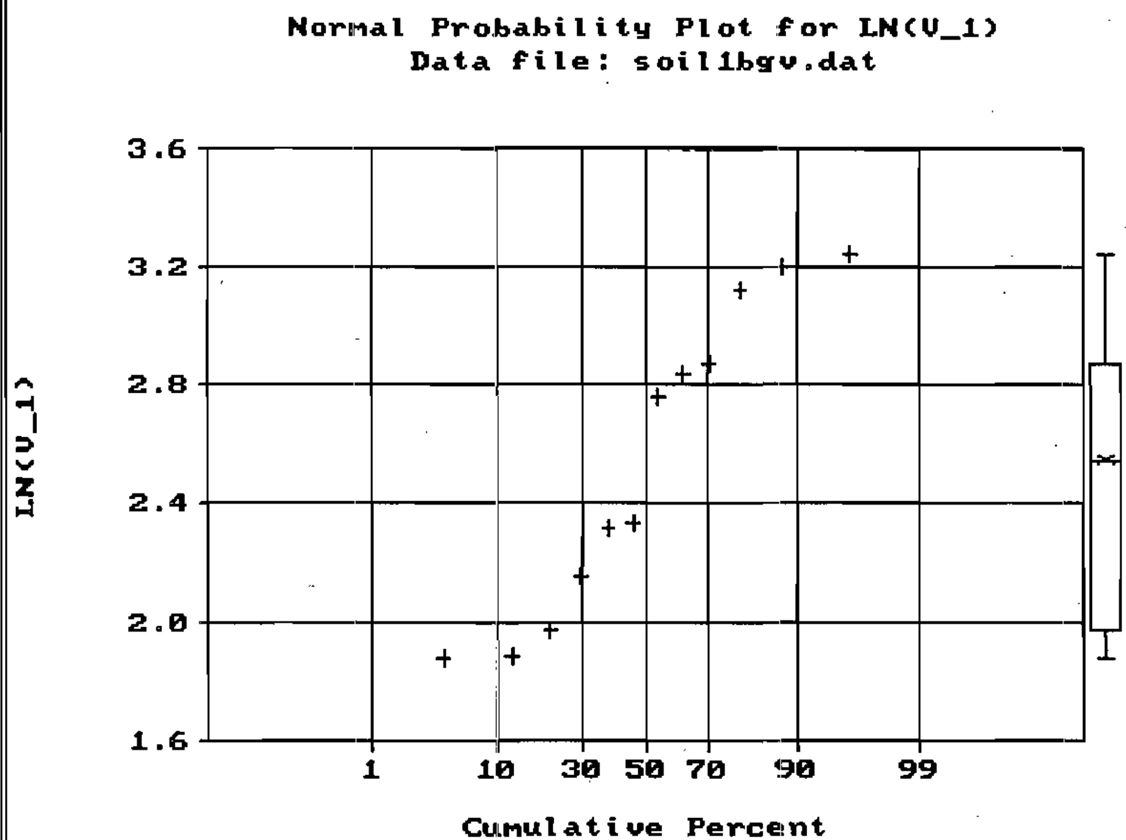
N Total :	13
N Miss :	1
N Used :	12
Mean :	2.546
Variance:	.269
Std. Dev:	.518
% C.V. :	20.360
Skewness:	.005
Kurtosis:	1.489
Minimum :	1.872
25th % :	1.967
Median :	2.546
75th % :	2.868
Maximum :	3.243

Zone B

V in surface soil grid samples

Alternative view of Fig. $6a_1$ showing greater detail

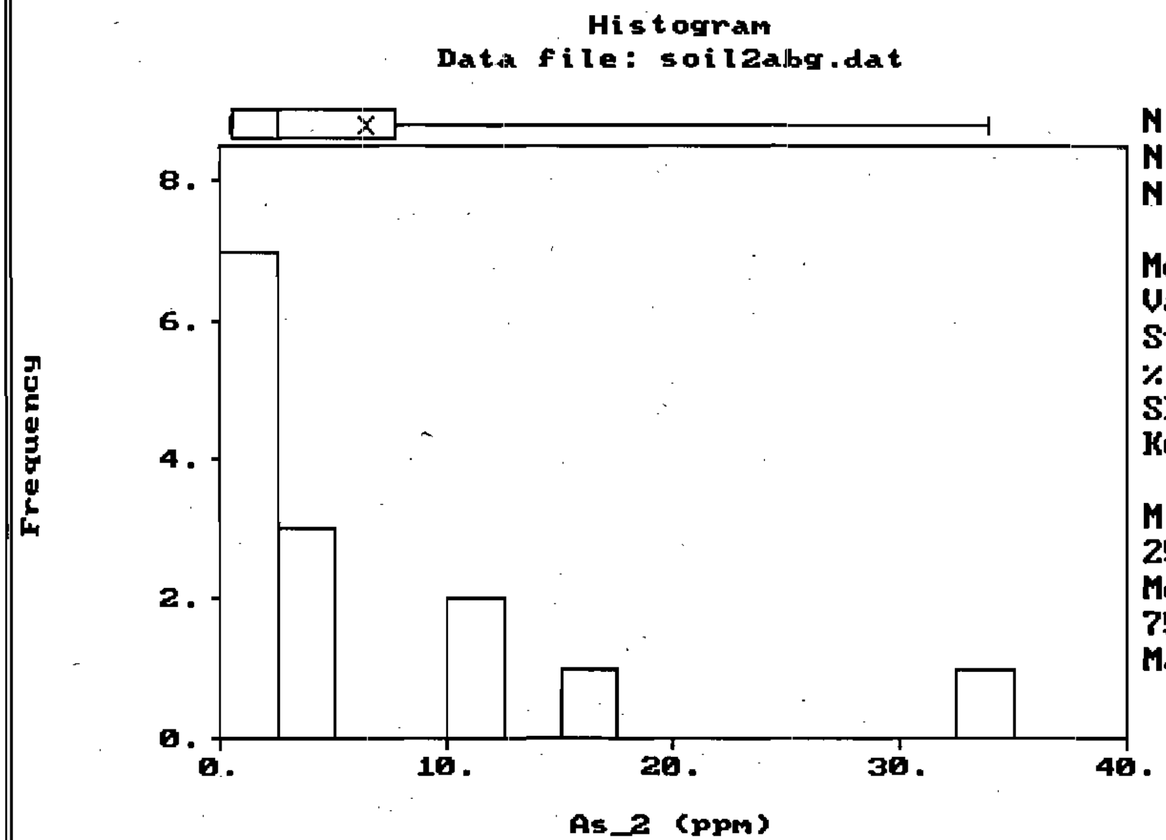




S t a t i s t i c s

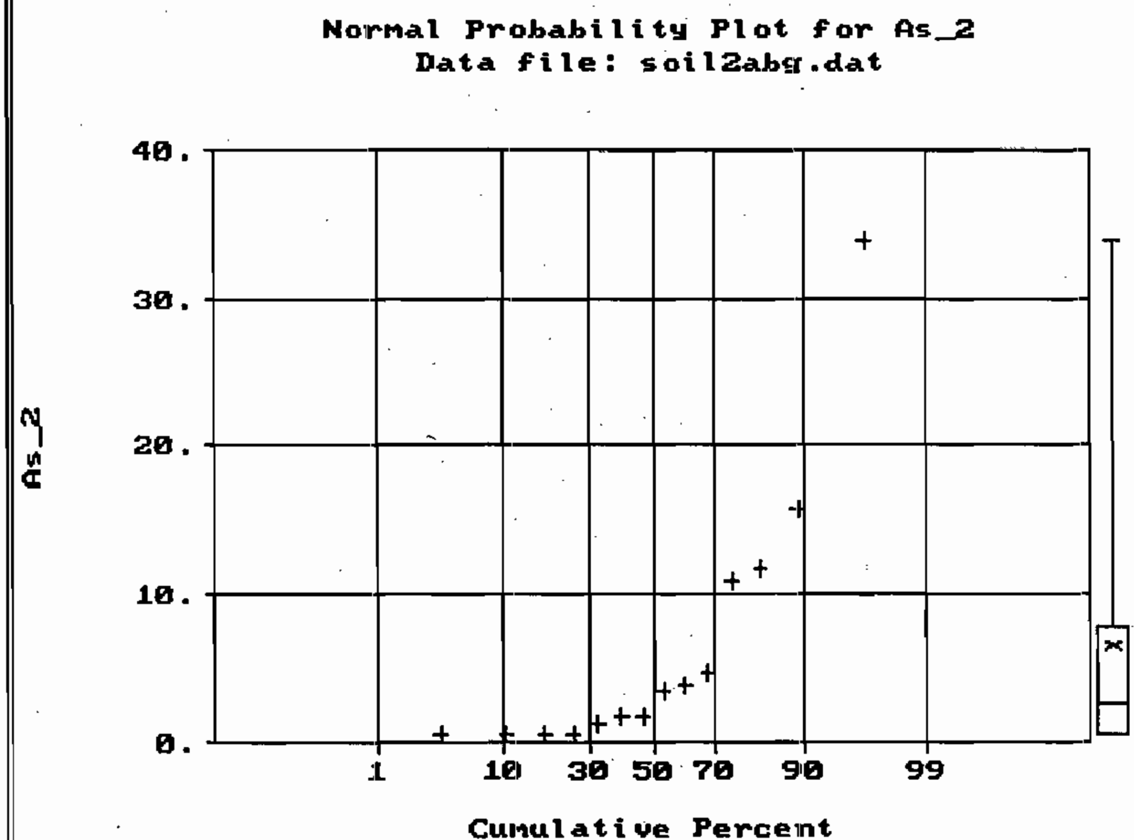
N Total :	13
N Miss :	1
N Used :	12
Mean :	2.546
Variance:	.269
Std. Dev:	.518
% C.V. :	20.360
Skewness:	.005
Kurtosis:	1.489
Minimum :	1.872
25th % :	1.967
Median :	2.546
75th % :	2.868
Maximum :	3.243

Zone B
Arsenic in subsurface soil
Original dataset (n = 14)
Original values



S t a t i s t i c s

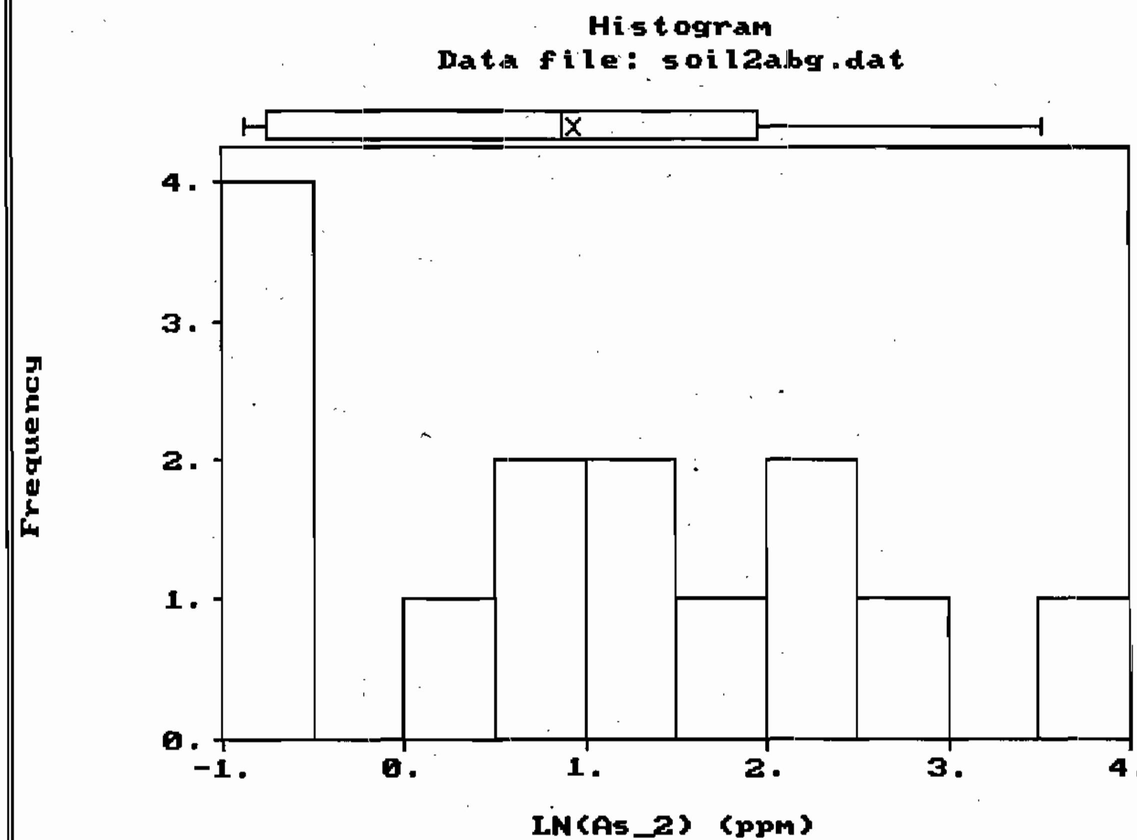
N Total :	14
N Miss :	0
N Used :	14
Mean :	6.463
Variance :	86.445
Std. Dev :	9.298
% C.V. :	143.870
Skewness :	2.027
Kurtosis :	6.459
Minimum :	.415
25th % :	.470
Median :	2.550
75th % :	7.750
Maximum :	33.900



S t a t i s t i c s

N Total	:	14
N Miss	:	0
N Used	:	14
Mean	:	6.463
Variance	:	86.445
Std. Dev	:	9.298
% C.V.	:	143.870
Skewness	:	2.027
Kurtosis	:	6.459
Minimum	:	.415
25th %	:	.470
Median	:	2.550
75th %	:	7.750
Maximum	:	33.900

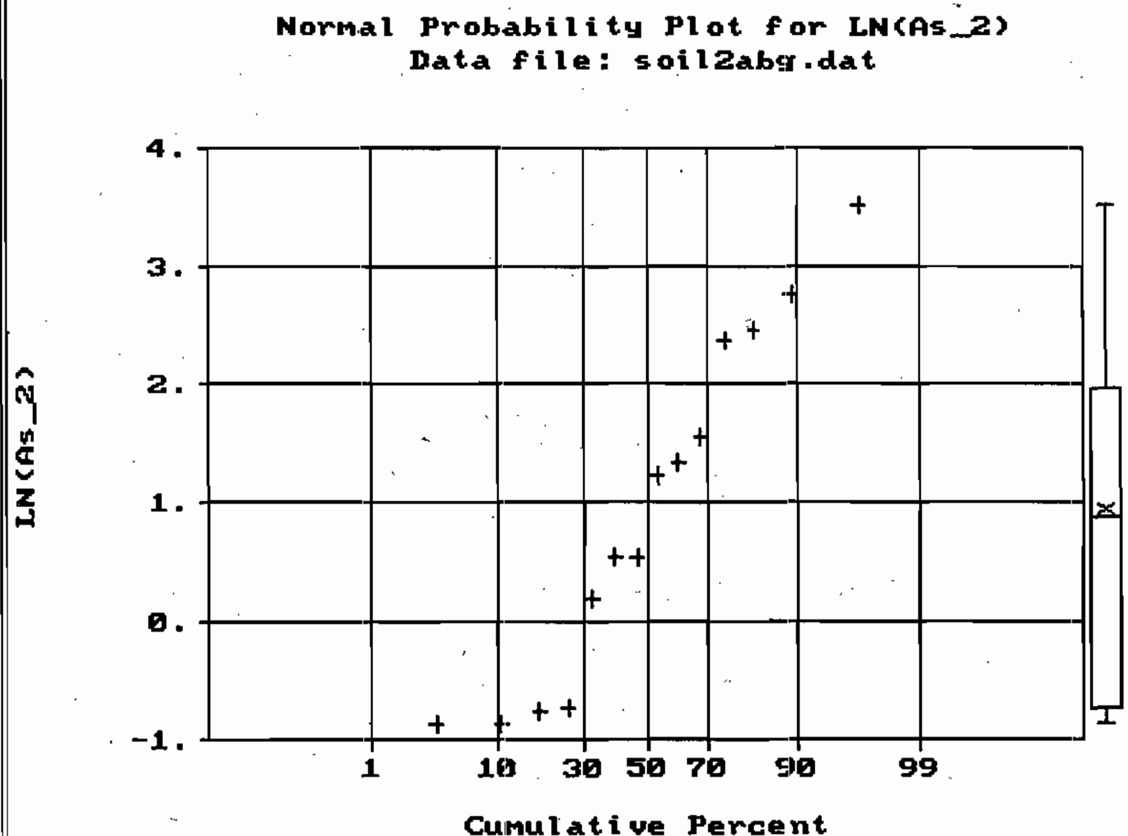
Zone B
AS in subsurface soil
Original dataset (N=14)
LN-transformed values



Statistics

N Total :	14
N Miss :	0
N Used :	14
Mean :	.944
Variance:	2.170
Std. Dev:	1.473
% C.V. :	156.056
Skewness:	.187
Kurtosis:	1.825
Minimum :	-.879
25th % :	-.755
Median :	.877
75th % :	1.964
Maximum :	3.523

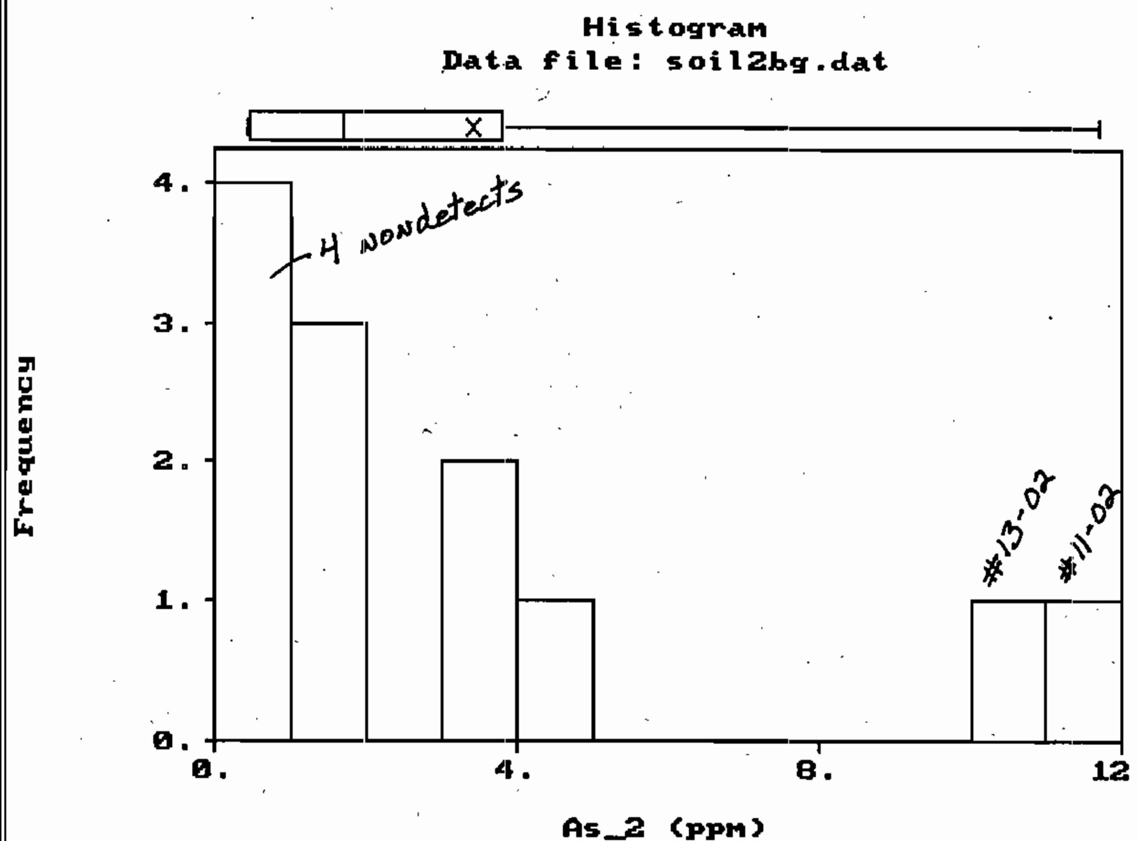
26



S t a t i s t i c s

N Total :	14
N Miss :	0
N Used :	14
Mean :	.944
Variance:	2.170
Std. Dev:	1.473
% C.V. :	156.056
Skewness:	.187
Kurtosis:	1.825
Minimum :	-.879
25th % :	-.755
Median :	.877
75th % :	1.964
Maximum :	3.523

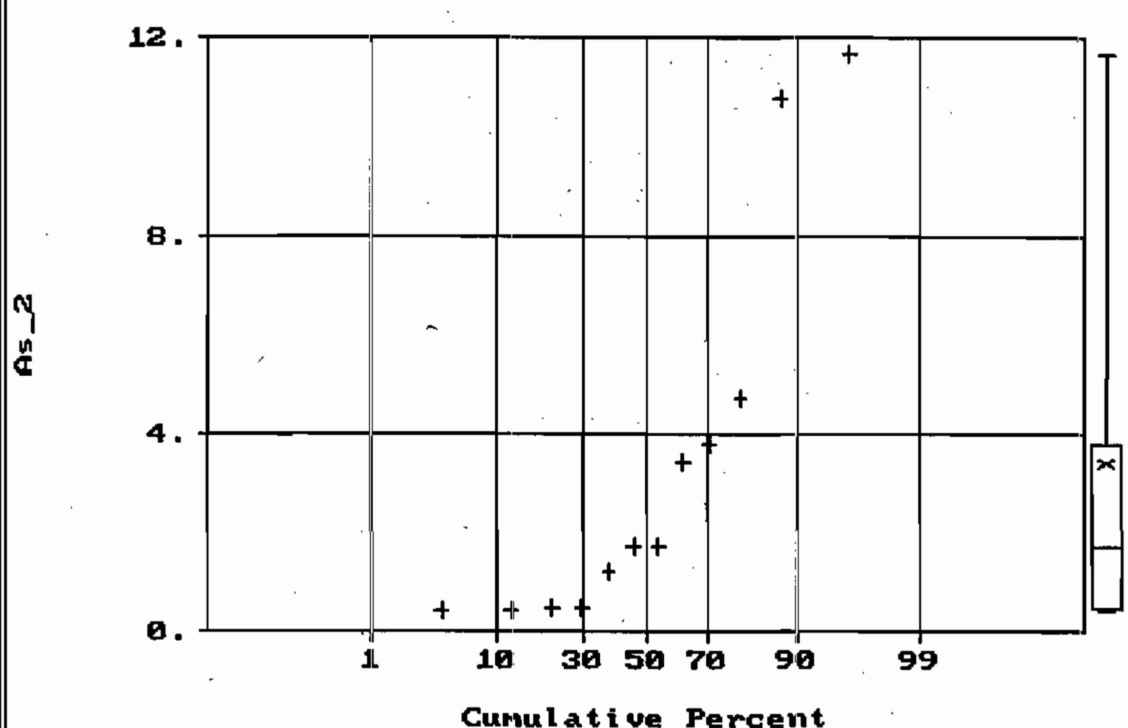
Zone D
AS in subsurface soil
Samples # 1-02 and 2-02 removed
Original values



S t a t i s t i c s

N Total :	12
N Miss :	0
N Used :	12
Mean :	3.398
Variance:	15.553
Std. Dev:	3.944
% C.V. :	116.062
Skewness:	1.326
Kurtosis:	3.321
Minimum :	.415
25th % :	.460
Median :	1.700
75th % :	3.800
Maximum :	11.700

Normal Probability Plot for As_2
Data file: soil2bg.dat

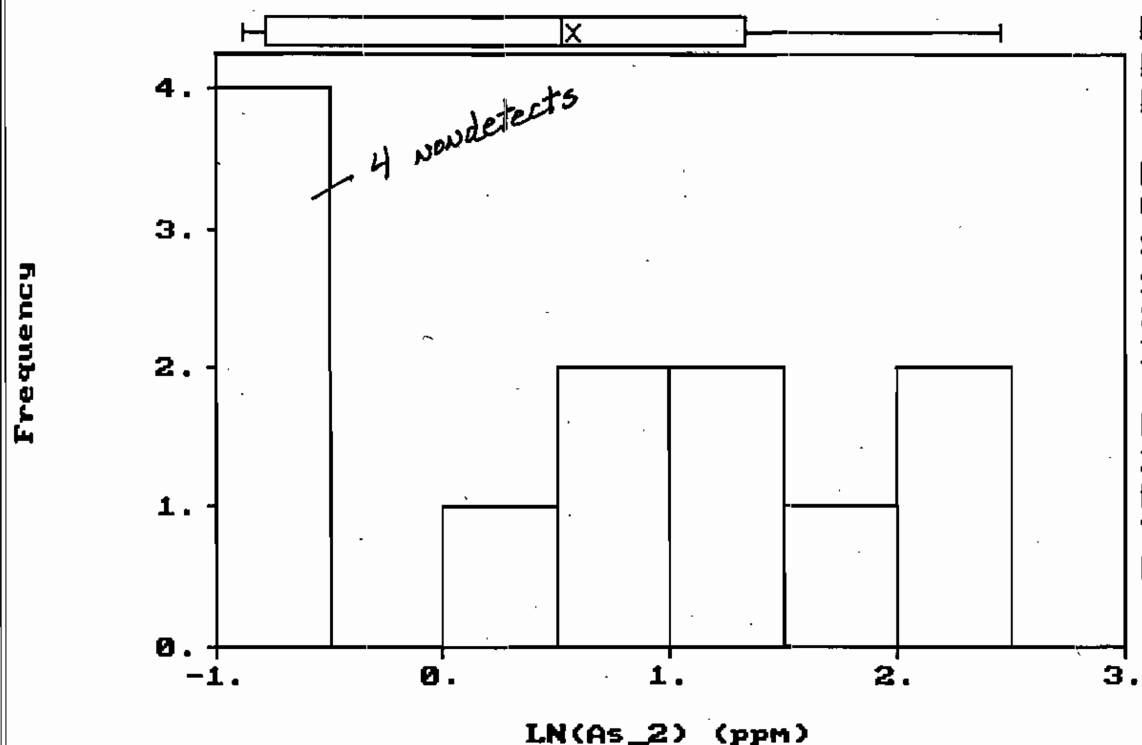


S t a t i s t i c s

N Total :	12
N Miss :	0
N Used :	12
Mean :	3.398
Variance:	15.553
Std. Dev:	3.944
% C.V. :	116.062
Skewness:	1.326
Kurtosis:	3.321
Minimum :	.415
25th % :	.460
Median :	1.700
75th % :	3.800
Maximum :	11.700

Zone B
AS in subsurface soil
Samples #1-02 and 2-02 removed
LN - transformed values

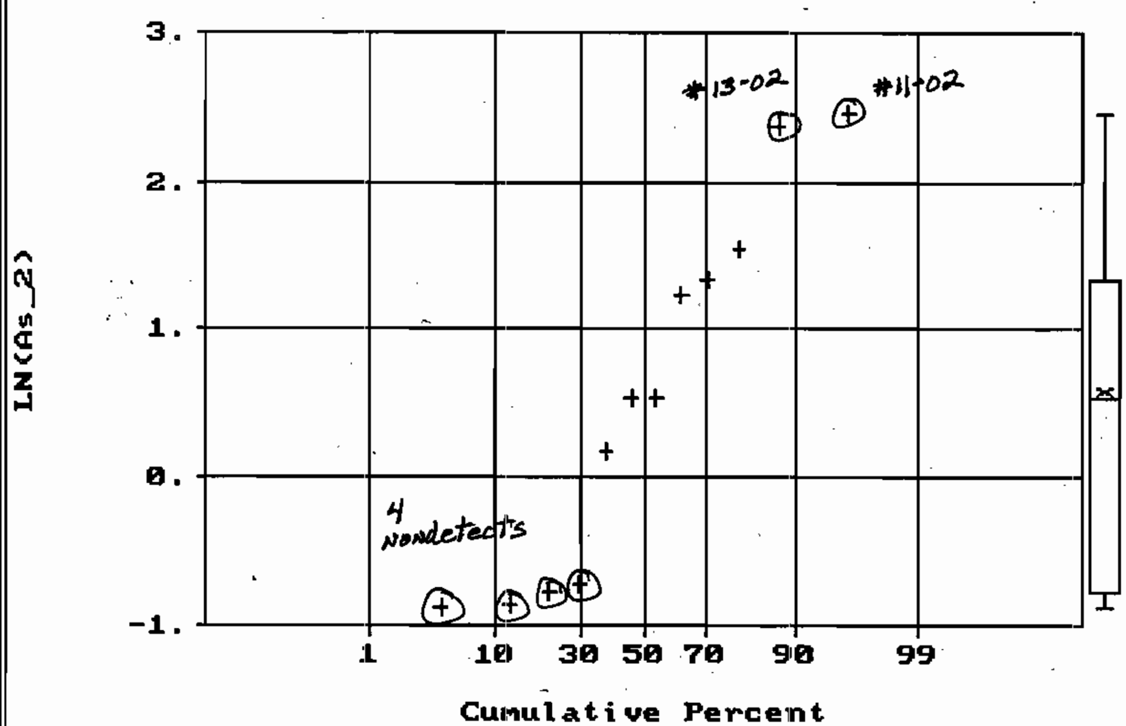
Histogram
Data file: soil2bg.dat



Statistics

N Total	:	12
N Miss	:	0
N Used	:	12
Mean	:	.578
Variance	:	1.513
Std. Dev	:	1.230
% C.V.	:	212.970
Skewness	:	.164
Kurtosis	:	1.719
Minimum	:	-.879
25th %	:	-.777
Median	:	.531
75th %	:	1.335
Maximum	:	2.460

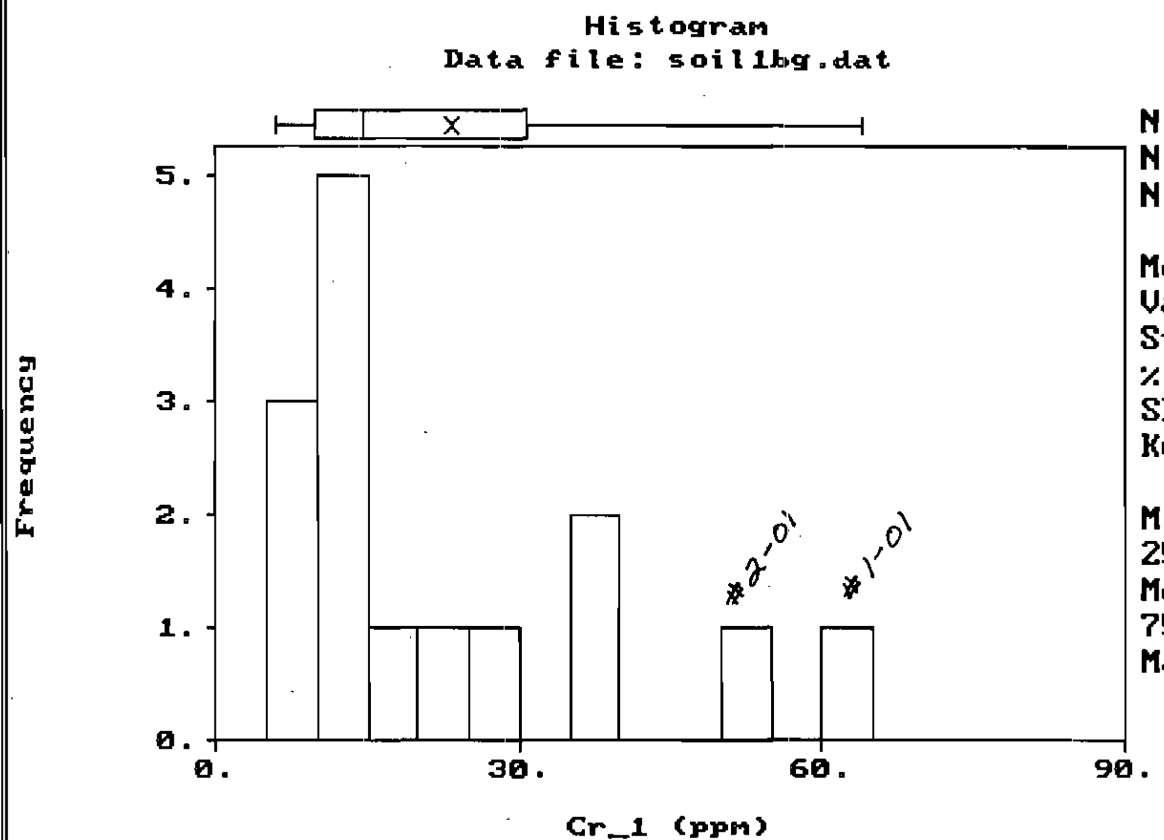
Normal Probability Plot for LN(As_2)
Data file: soil2bg.dat



S t a t i s t i c s

N Total :	12
N Miss :	0
N Used :	12
Mean :	.578
Variance:	1.513
Std. Dev:	1.230
% C.V. :	212.970
Skewness:	.164
Kurtosis:	1.719
Minimum :	-.879
25th % :	-.777
Median :	.531
75th % :	1.335
Maximum :	2.460

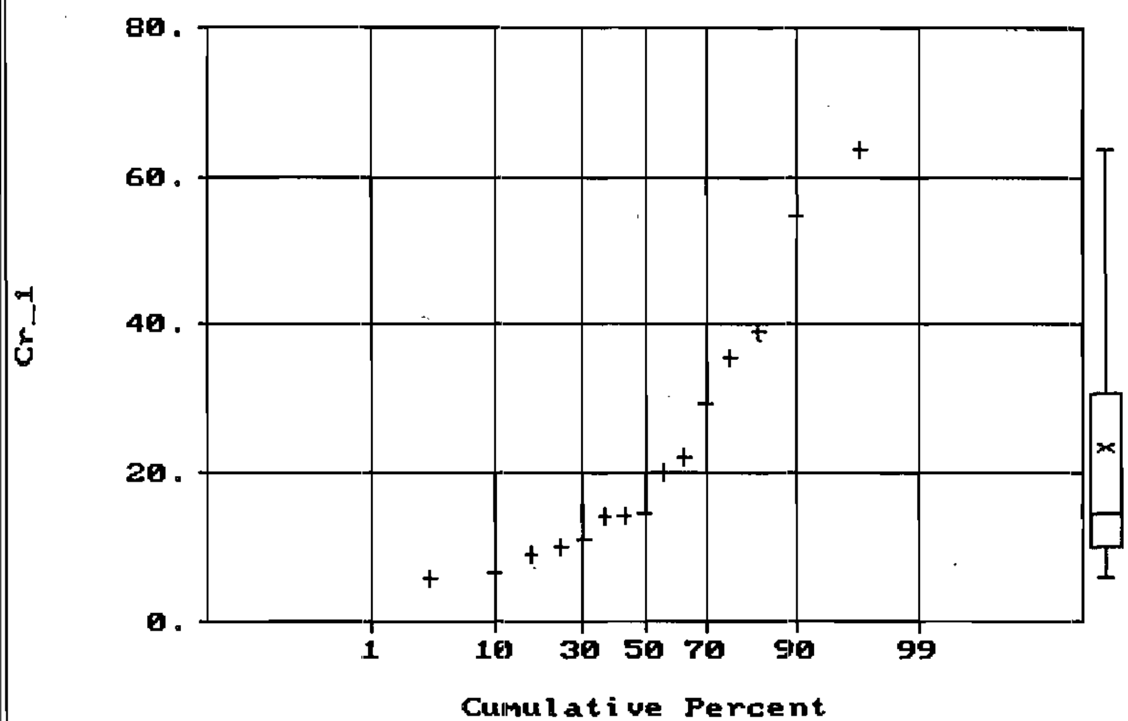
Zone B
Chromium in surface soil grid samples
Original dataset (N=15)
Original values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	23.330
Variance:	316.763
Std. Dev:	17.798
% C.V. :	76.287
Skewness:	1.101
Kurtosis:	3.076
Minimum :	5.950
25th % :	9.825
Median :	14.600
75th % :	30.900
Maximum :	63.800

Normal Probability Plot for Cr_1
Data file: soil1bg.dat



Statistics

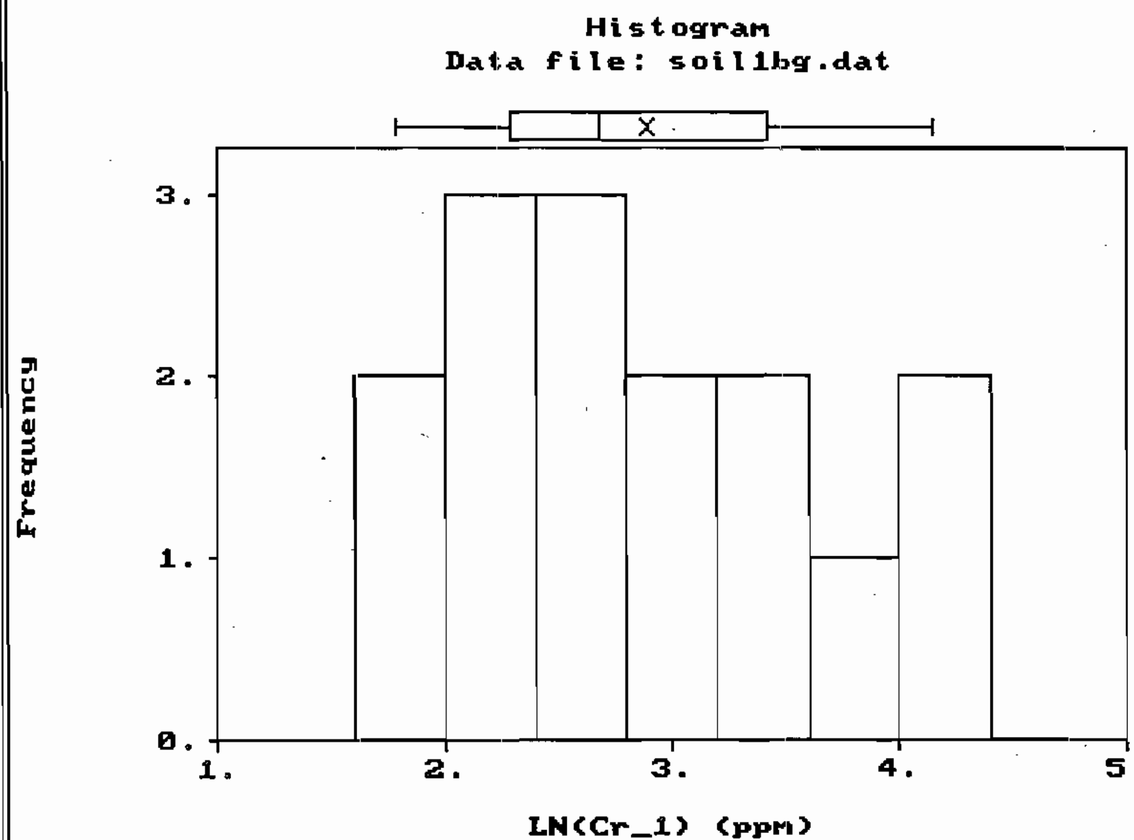
N Total	:	15
N Miss	:	0
N Used	:	15
Mean	:	23.330
Variance	:	316.763
Std. Dev	:	17.798
% C.V.	:	76.287
Skewness	:	1.101
Kurtosis	:	3.076
Minimum	:	5.950
25th %	:	9.825
Median	:	14.600
75th %	:	30.900
Maximum	:	63.800

Zone B

CR in surface soil grid samples

Original dataset (N=15)

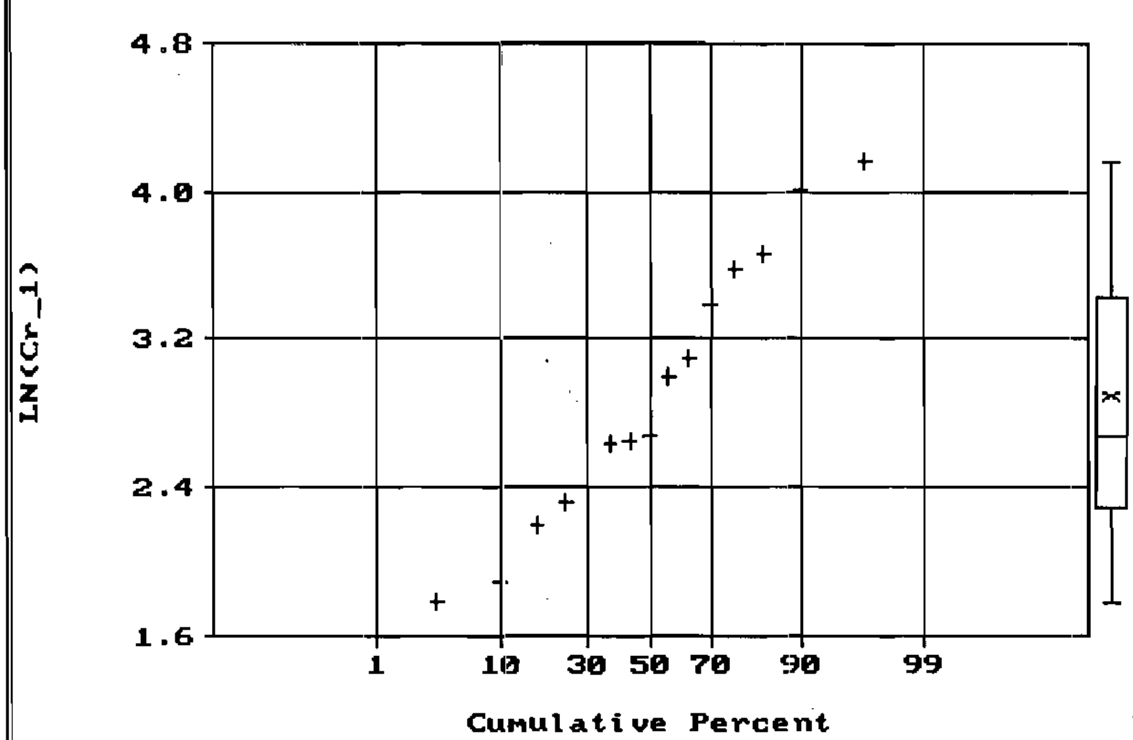
LN-transformed values



Statistics

N Total :	15
N Miss :	0
N Used :	15
Mean :	2.894
Variance:	.546
Std. Dev:	.739
% C.V. :	25.542
Skewness:	.216
Kurtosis:	1.958
Minimum :	1.783
25th % :	2.284
Median :	2.681
75th % :	3.427
Maximum :	4.156

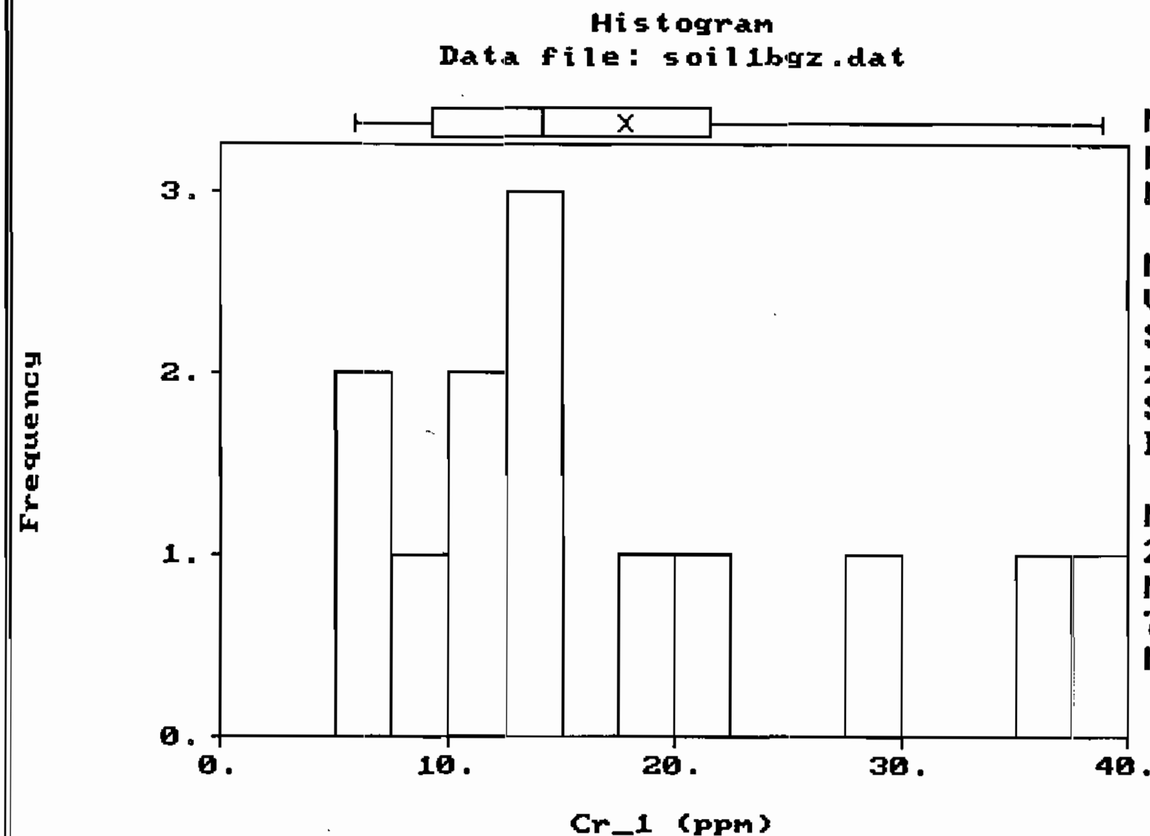
Normal Probability Plot for LN(Cr_1)
Data file: soil1bg.dat



S t a t i s t i c s

N Total :	15
N Miss :	0
N Used :	15
Mean :	2.894
Variance:	.546
Std. Dev:	.739
% C.V. :	25.542
Skewness:	.216
Kurtosis:	1.958
Minimum :	1.783
25th % :	2.284
Median :	2.681
75th % :	3.427
Maximum :	4.156

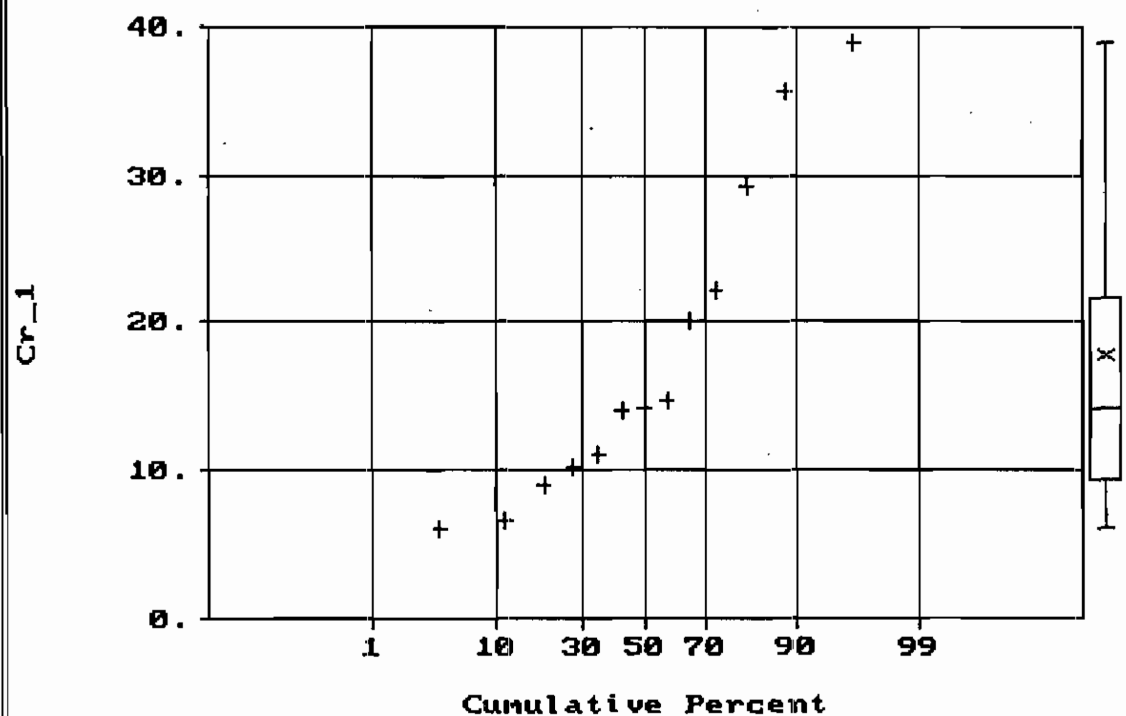
Zone B
CR in surface soil grid samples
Samples #1-01 and 2-01 removed
Original values



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	17.796
Variance:	117.367
Std. Dev:	10.834
% C.V. :	60.876
Skewness:	.825
Kurtosis:	2.402
Minimum :	5.950
25th % :	9.275
Median :	14.100
75th % :	21.575
Maximum :	38.900

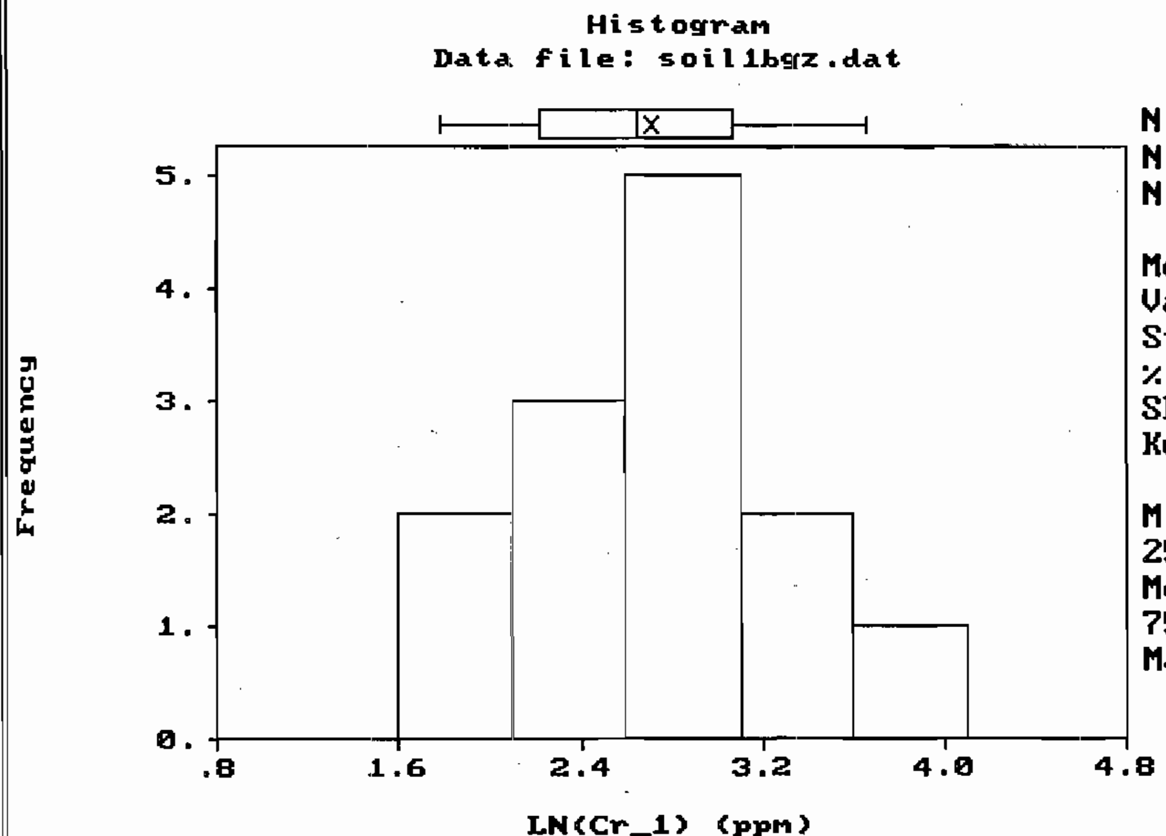
Normal Probability Plot for Cr_1
Data file: soil1bgz.dat



S t a t i s t i c s

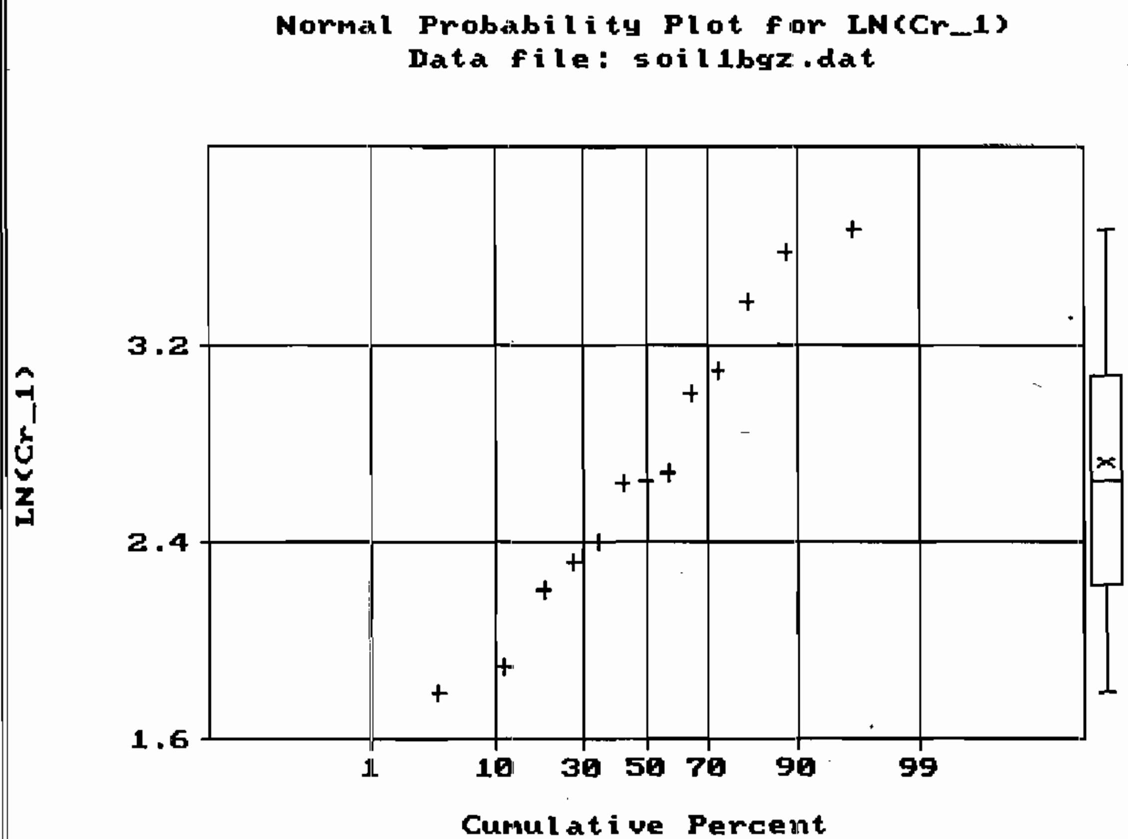
N Total :	13
N Miss :	0
N Used :	13
Mean :	17.796
Variance:	117.367
Std. Dev:	10.834
% C.V. :	60.876
Skewness:	.825
Kurtosis:	2.402
Minimum :	5.950
25th % :	9.275
Median :	14.100
75th % :	21.575
Maximum :	38.900

Zone B
CR in surface soil grid samples
Samples #1-01 and 2-01 removed
LN-transformed values



Statistics

N Total :	13
N Miss :	0
N Used :	13
Mean :	2.711
Variance:	.366
Std. Dev:	.605
% C.V. :	22.314
Skewness:	.111
Kurtosis:	1.956
Minimum :	1.783
25th % :	2.226
Median :	2.646
75th % :	3.071
Maximum :	3.661



S t a t i s t i c s

N Total :	13
N Miss :	0
N Used :	13
Mean :	2.711
Variance:	.366
Std. Dev:	.605
% C.V. :	22.314
Skewness:	.111
Kurtosis:	1.956
Minimum :	1.783
25th % :	2.226
Median :	2.646
75th % :	3.071
Maximum :	3.661

VCHEM_R
02/28/97

ENVIRONMENTAL SAFETY & DESIGNS

2902-00001 - CHARLESTON ZONE B - SOIL & 1ST GW

Samples by Chemical Report

7440-47-3 - Chromium (Cr)

>= 0.0000 for MG/KG

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
507-S-B001-01	507SB00101	Soil	10/04/95	9.1000		MG/KG	L5540S	VAL
507-S-B001-02	507SB00102	Soil	10/04/95	2.9000		MG/KG	L5540S	VAL
507-S-B002-01	507SB00201	Soil	10/04/95	9.3000		MG/KG	L5540S	VAL
507-S-B002-02	507SB00202	Soil	10/04/95	3.3000		MG/KG	L5540S	VAL
507-S-B003-01	507SB00301	Soil	10/04/95	18.1000		MG/KG	L5540S	VAL
507-S-B003-02	507SB00302	Soil	10/04/95	4.6000		MG/KG	L5540S	VAL
507-S-B004-01	507SB00401	Soil	10/04/95	7.2000		MG/KG	L5540S	VAL
507-C-B004-01	507CB00401	Soil	10/04/95	5.0000		MG/KG	L5530S	VAL
507-S-B004-02	507SB00402	Soil	10/04/95	4.5000		MG/KG	L5540S	VAL
507-S-B005-01	507SB00501	Soil	10/04/95	6.0000		MG/KG	L5540S	VAL
507-S-B005-02	507SB00502	Soil	10/04/95	7.4000		MG/KG	L5540S	VAL
GDB-S-B001-01	GDBSB00101	Soil	10/04/95	74.3000		MG/KG	L5540S	VAL
GDB-C-B001-01	GDBCB00101	Soil	10/04/95	53.3000		MG/KG	L5530S	VAL
GDB-S-B001-02	GDBSB00102	Soil	10/04/95	75.7000		MG/KG	L5540S	VAL
GDB-S-B002-01	GDBSB00201	Soil	10/04/95	54.8000		MG/KG	L5540S	VAL
GDB-S-B002-02	GDBSB00202	Soil	10/04/95	48.5000		MG/KG	L5540S	VAL
GDB-S-B003-01	GDBSB00301	Soil	10/04/95	20.0000		MG/KG	L5540S	VAL
GDB-S-B004-01	GDBSB00401	Soil	10/04/95	9.0000		MG/KG	L5540S	VAL
GDB-S-B004-02	GDBSB00402	Soil	10/04/95	4.4000		MG/KG	L5540S	VAL
GDB-S-B005-01	GDBSB00501	Soil	10/04/95	14.1000		MG/KG	L5540S	VAL
GDB-S-B005-02	GDBSB00502	Soil	10/04/95	4.5000		MG/KG	L5540S	VAL
GDB-S-B006-01	GDBSB00601	Soil	10/04/95	14.6000		MG/KG	L5540S	VAL
GDB-S-B006-02	GDBSB00602	Soil	10/04/95	26.6000		MG/KG	L5540S	VAL
GDB-S-B007-01	GDBSB00701	Soil	10/04/95	14.0000		MG/KG	L5540S	VAL
GDB-S-B007-02	GDBSB00702	Soil	10/04/95	10.4000		MG/KG	L5540S	VAL
GDB-S-B008-01	GDBSB00801	Soil	10/04/95	6.0000		MG/KG	L5540S	VAL
GDB-C-B008-01	GDBCB00801	Soil	10/04/95	5.9000		MG/KG	L5530S	VAL
GDB-S-B008-02	GDBSB00802	Soil	10/04/95	2.6000		MG/KG	L5540S	VAL
GDB-S-B009-01	GDBSB00901	Soil	10/04/95	11.0000		MG/KG	L5540S	VAL
GDB-S-B009-02	GDBSB00902	Soil	10/04/95	4.4000		MG/KG	L5540S	VAL
GDB-S-B010-01	GDBSB01001	Soil	10/04/95	35.7000		MG/KG	L5540S	VAL
GDB-S-B010-02	GDBSB01002	Soil	10/04/95	48.1000		MG/KG	L5540S	VAL
GDB-S-B011-01	GDBSB01101	Soil	10/04/95	38.9000		MG/KG	L5540S	VAL
GDB-S-B011-02	GDBSB01102	Soil	10/04/95	11.4000		MG/KG	L5540S	VAL
GDB-S-B012-01	GDBSB01201	Soil	10/04/95	6.6000		MG/KG	L5540S	VAL
GDB-S-B012-02	GDBSB01202	Soil	10/04/95	5.9000		MG/KG	L5540S	VAL
GDB-S-B013-01	GDBSB01301	Soil	10/04/95	29.3000		MG/KG	L5540S	VAL
GDB-S-B013-02	GDBSB01302	Soil	10/04/95	23.7000		MG/KG	L5540S	VAL
GDB-S-B014-01	GDBSB01401	Soil	10/04/95	10.1000		MG/KG	L5540S	VAL
GDB-S-B014-02	GDBSB01402	Soil	10/04/95	2.5000		MG/KG	L5540S	VAL
GDB-S-B015-01	GDBSB01501	Soil	10/04/95	22.1000		MG/KG	L5540S	VAL
GDB-S-B015-02	GDBSB01502	Soil	10/04/95	4.8000		MG/KG	L5540S	VAL

*** End of Report ***

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2902-00001 - CHARLESTON ZONE B - SOIL & 1ST GW

Samples by Chemical Report

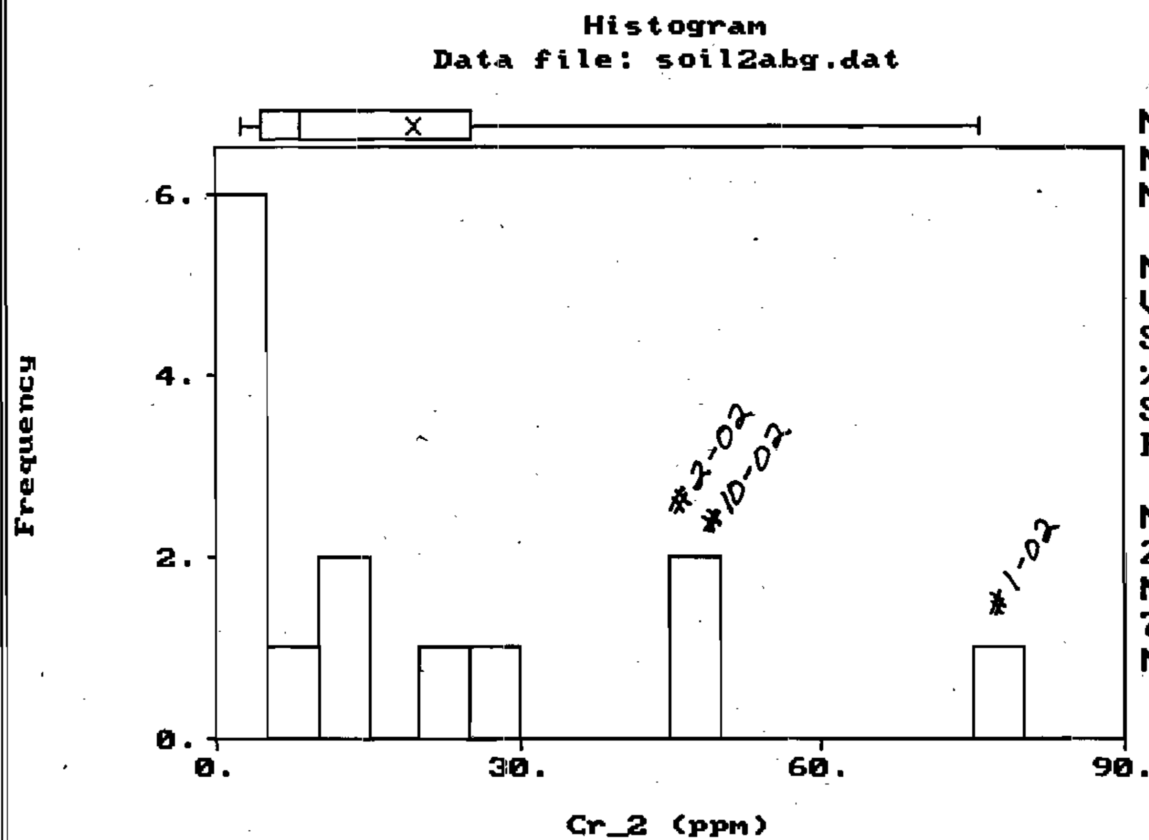
18540-29-9 - Chromium (Hexavalent)

>= 0.0000 for MG/KG

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
507-C-B004-01	507CB00401	Soil	10/04/95	0.3000		MG/KG	L5530I	VAL
GDB-C-B001-01	GDBCB00101	Soil	10/04/95	0.1500	U	MG/KG	L5530I	VAL
GDB-C-B008-01	GDBCB00801	Soil	10/04/95	0.1300	U	MG/KG	L5530I	VAL

*** End of Report ***

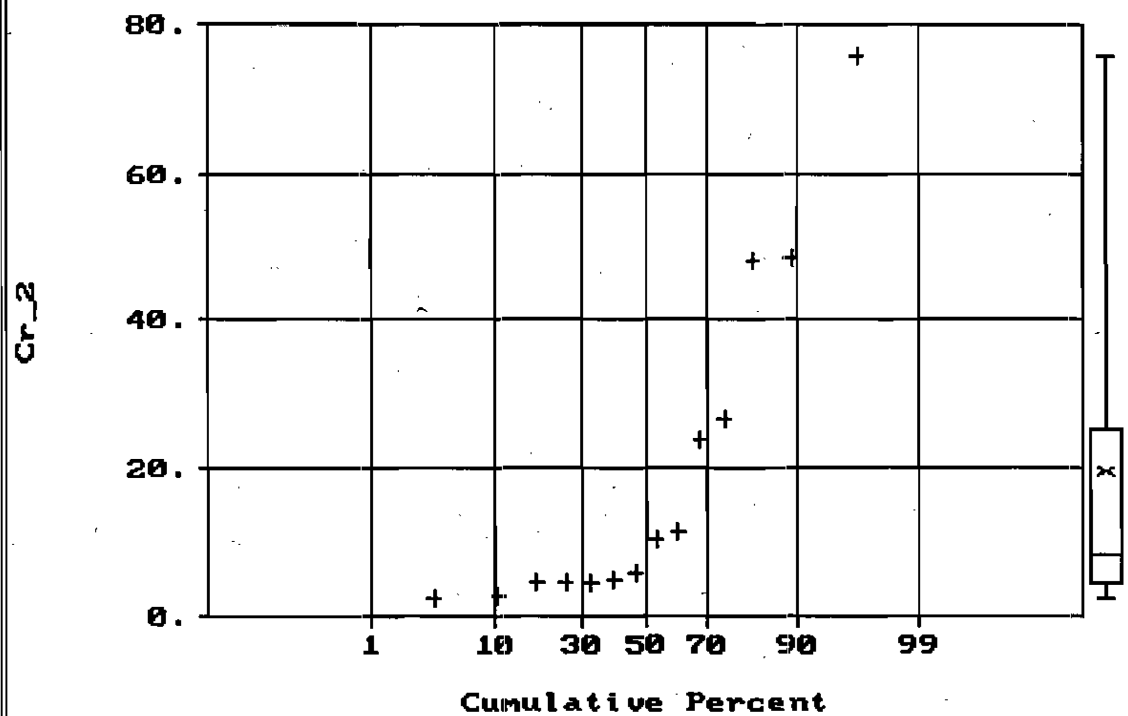
Zone B
Chromium in subsurface soil
Original dataset (N=14)
Original values



Statistics

N Total	:	14
N Miss	:	0
N Used	:	14
Mean	:	19.536
Variance	:	514.656
Std. Dev	:	22.686
% C.V.	:	116.126
Skewness	:	1.354
Kurtosis	:	3.671
Minimum	:	2.500
25th %	:	4.400
Median	:	8.150
75th %	:	25.150
Maximum	:	75.700

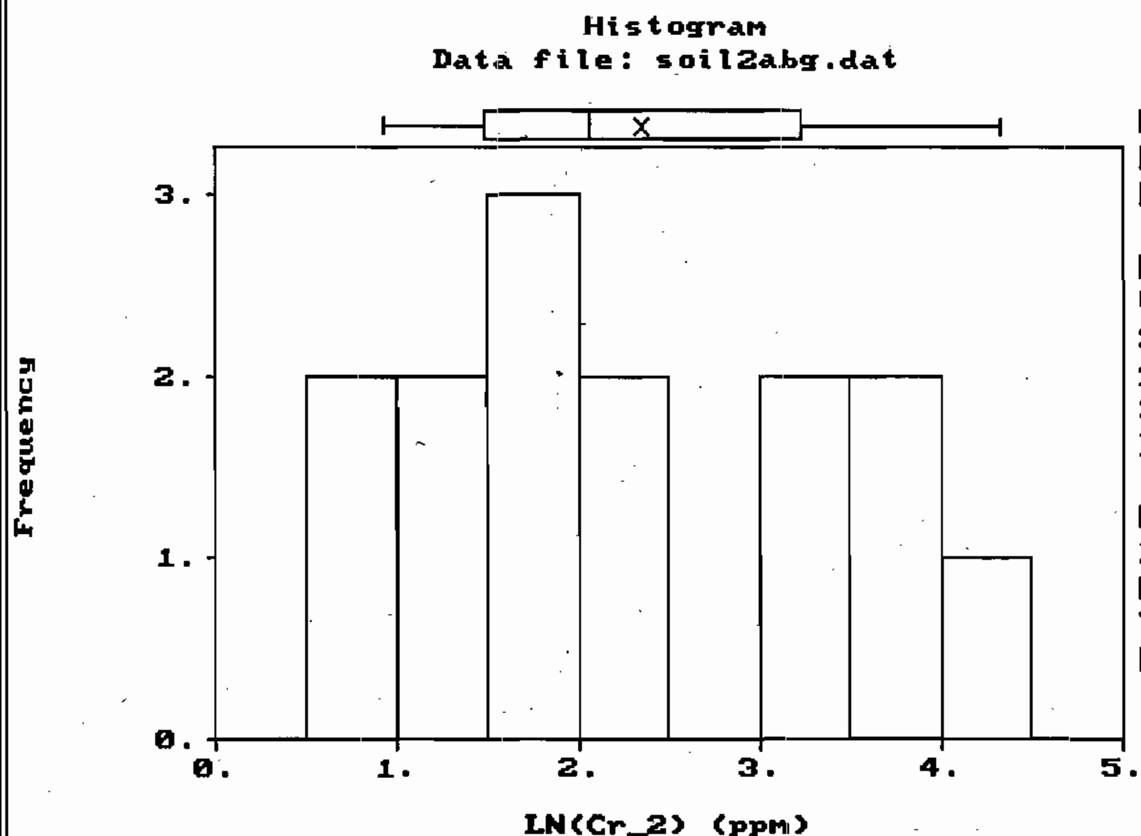
Normal Probability Plot for Cr_2
Data file: soil2abg.dat



Statistics

N Total :	14
N Miss :	0
N Used :	14
Mean :	19.536
Variance:	514.656
Std. Dev:	22.686
% C.V. :	116.126
Skewness:	1.354
Kurtosis:	3.671
Minimum :	2.500
25th % :	4.400
Median :	8.150
75th % :	25.150
Maximum :	75.700

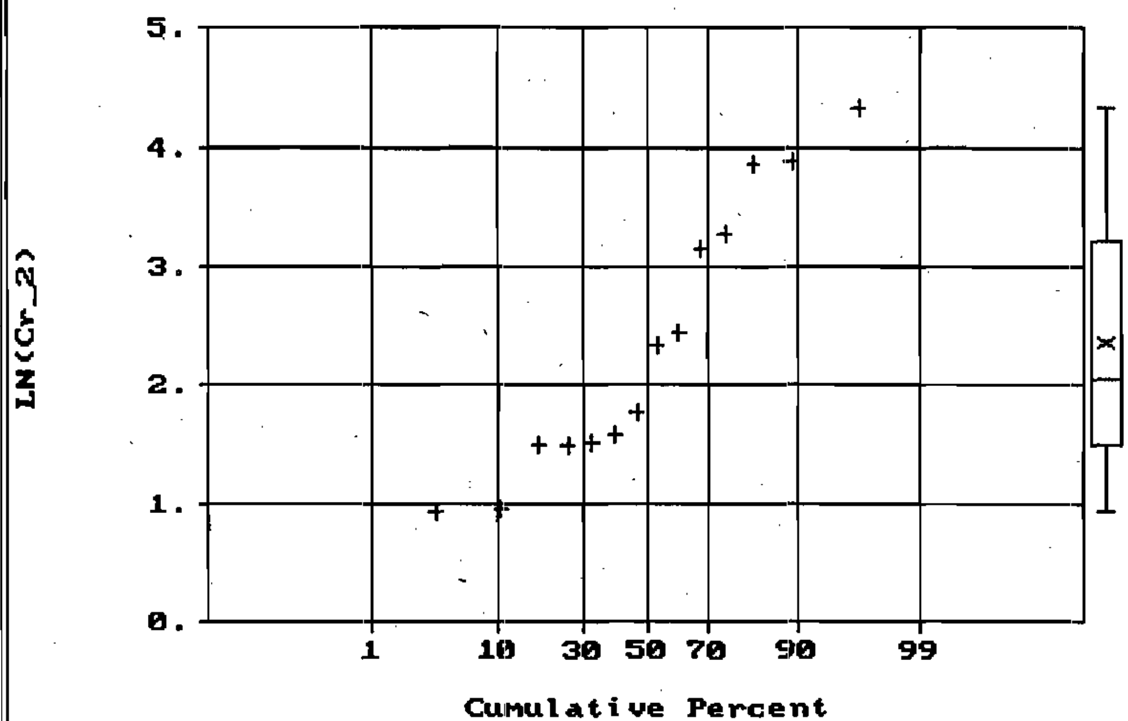
Zone 2
CR in subsurface soil
Original dataset (N=14)
LN-transformed values



Statistics

N Total :	14
N Miss :	0
N Used :	14
Mean :	2.356
Variance:	1.329
Std. Dev:	1.153
% C.V. :	48.928
Skewness:	.398
Kurtosis:	1.749
Minimum :	.916
25th % :	1.482
Median :	2.058
75th % :	3.223
Maximum :	4.327

Normal Probability Plot for LN(Cr_2)
Data file: soil2abg.dat



Statistics

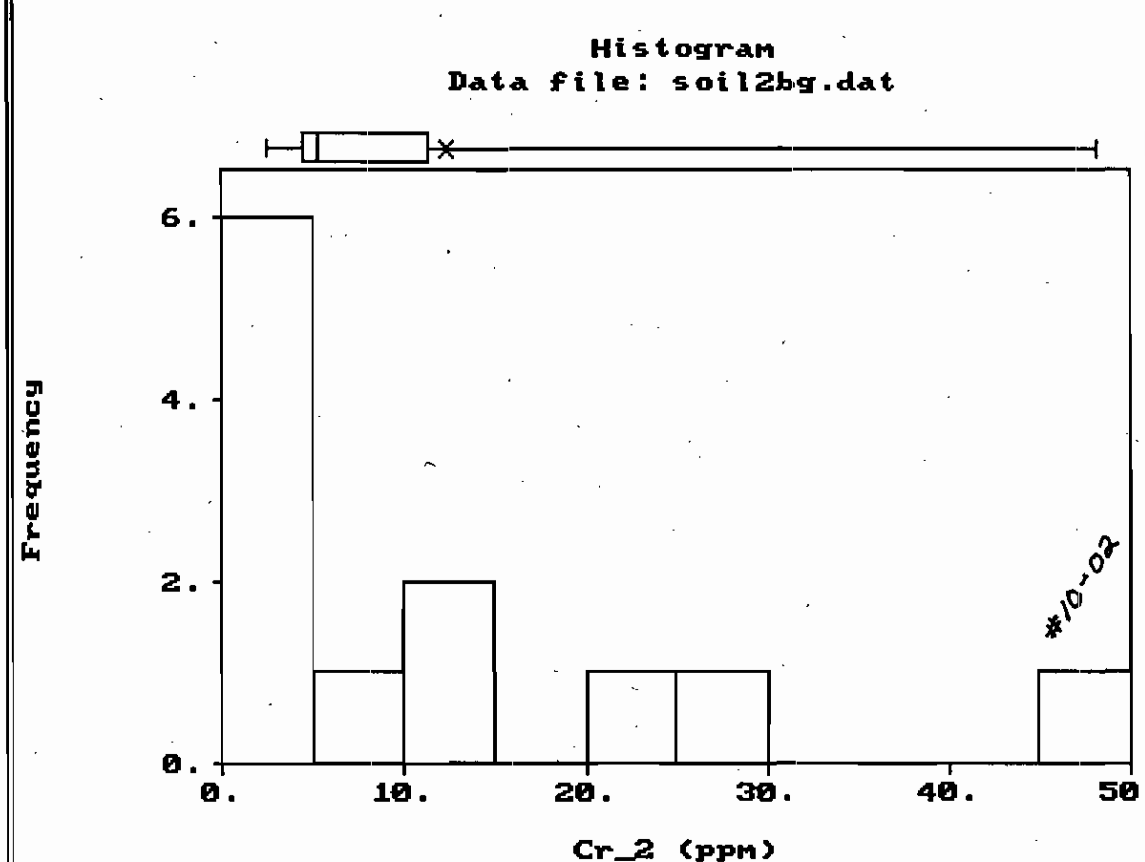
N Total	:	14
N Miss	:	0
N Used	:	14
Mean	:	2.356
Variance	:	1.329
Std. Dev	:	1.153
% C.V.	:	48.928
Skewness	:	.398
Kurtosis	:	1.749
Minimum	:	.916
25th %	:	1.482
Median	:	2.058
75th %	:	3.223
Maximum	:	4.327

Zone B

CR in subsurface soil

Samples #1-02 and 2-02 removed

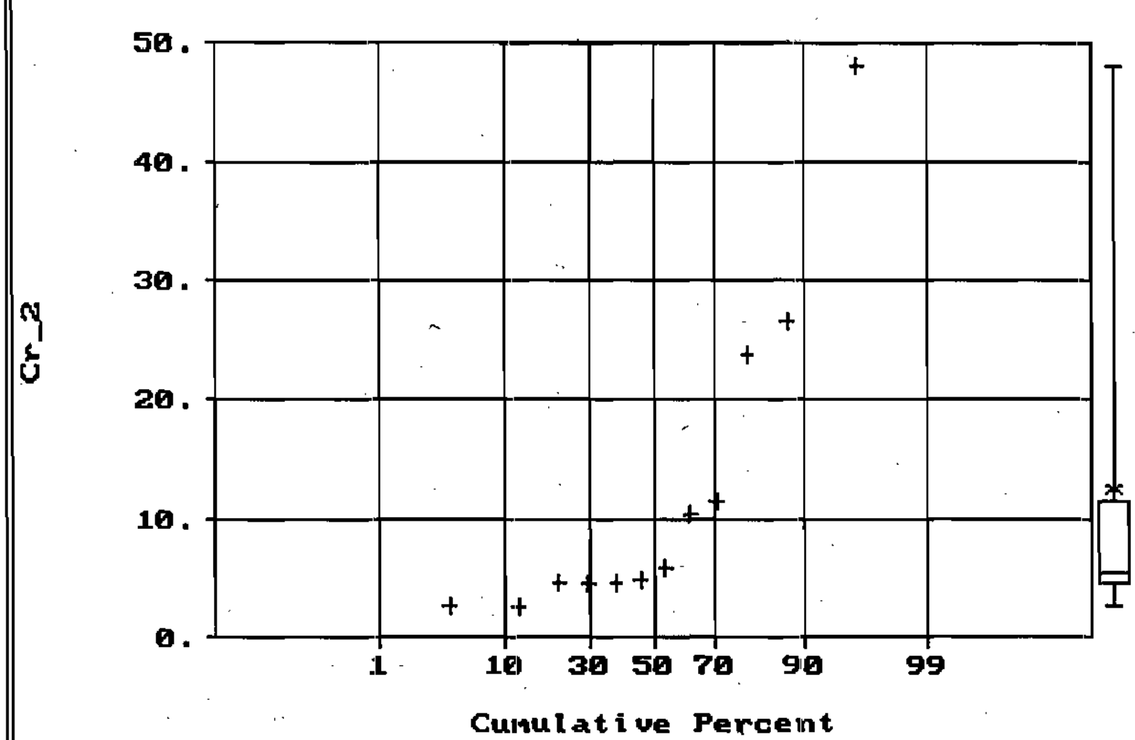
Original values



Statistics

N Total :	12
N Miss :	0
N Used :	12
Mean :	12.442
Variance:	190.297
Std. Dev:	13.795
% C.V. :	110.876
Skewness:	1.642
Kurtosis:	4.682
Minimum :	2.500
25th % :	4.400
Median :	5.350
75th % :	11.400
Maximum :	48.100

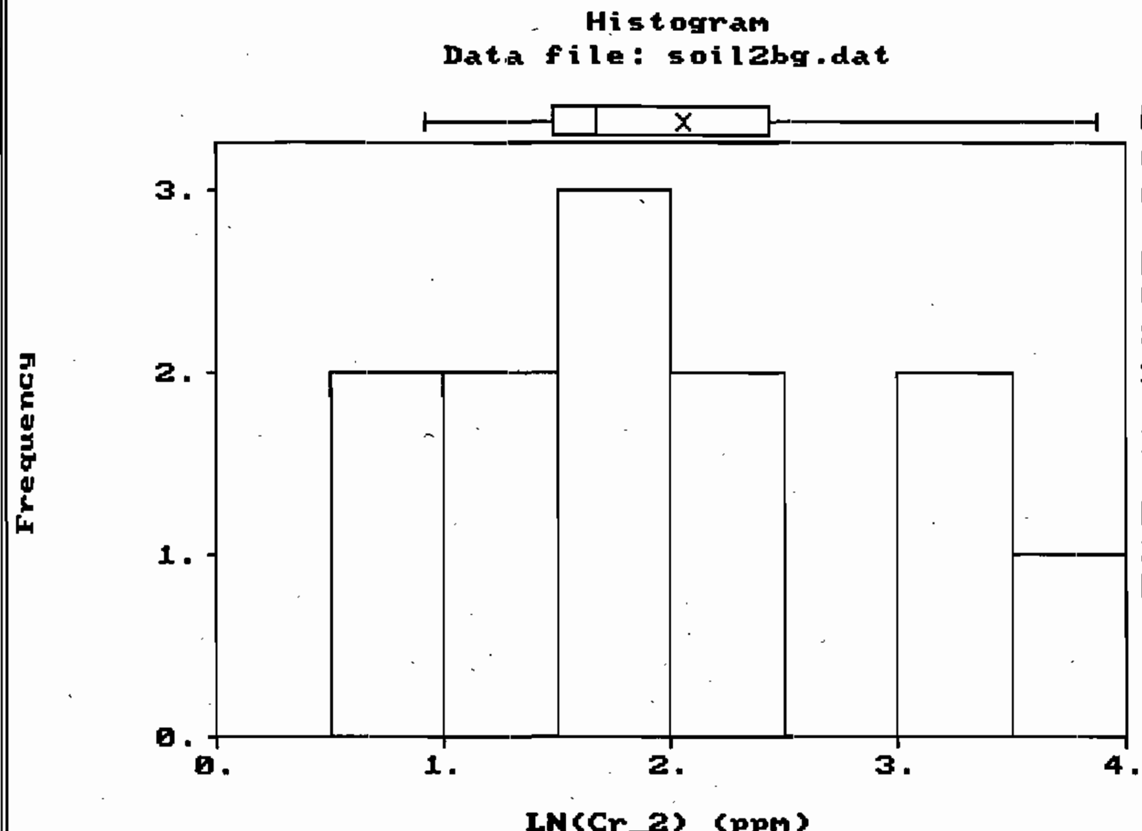
Normal Probability Plot for Cr_2
Data file: soil2bg.dat



S t a t i s t i c s

N Total	:	12
N Miss	:	0
N Used	:	12
Mean	:	12.442
Variance	:	190.297
Std. Dev	:	13.795
% C.V.	:	110.876
Skewness	:	1.642
Kurtosis	:	4.682
Minimum	:	2.500
25th %	:	4.400
Median	:	5.350
75th %	:	11.400
Maximum	:	48.100

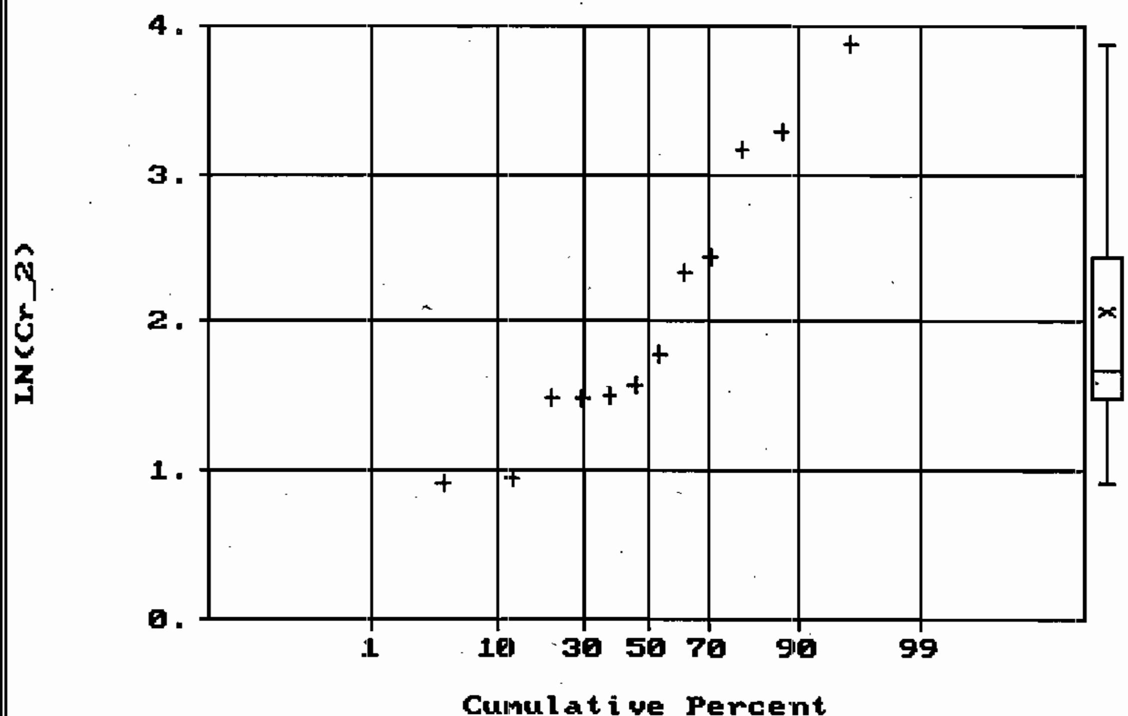
Zone B
CR in subsurface soil
Samples #1-02 and 2-02 removed
LN- transformed values



S t a t i s t i c s

N Total :	12
N Miss :	0
N Used :	12
Mean :	2.065
Variance:	.913
Std. Dev:	.956
% C.V. :	46.288
Skewness:	.600
Kurtosis:	2.143
Minimum :	.916
25th % :	1.482
Median :	1.672
75th % :	2.434
Maximum :	3.873

Normal Probability Plot for LN(Cr_2)
Data file: soil2bg.dat



S t a t i s t i c s

N Total :	12
N Miss :	0
N Used :	12
Mean :	2.065
Variance:	.913
Std. Dev:	.956
% C.V. :	46.288
Skewness:	.600
Kurtosis:	2.143
Minimum :	.916
25th % :	1.482
Median :	1.672
75th % :	2.434
Maximum :	3.873